THE UNIVERSITY OF ALBERTA

MONETARY RETURNS TO EDUCATIONAL PROGRAMS: THE ENGINEERING TECHNOLOGIES IN ALBERTA

by

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ABSTRACT

This study consists of an examination of the social and private monetary returns to programs in the Engineering Technologies in Alberta in 1971. The programs are the one-year course of study leading to the Certificate in Engineering Technology and the two-year course leading to the Diploma in Engineering Technology, courses offered at the Northern Alberta Institute of Technology and the Southern Alberta Institute of Technology.

Analytically, education is treated as a form of investment; the procedures of human capital model are applied. The results are examined for their implications for on-going educational planning in the province. The analysis however does not include the non-economic benefits of education, the rationale being that in such programs the labour-market relevance of the skill rather than its aesthetic and other non-pecuniary aspects has primacy over the monetary factors.

The results show that while the private internal rates of return seem high, the present capital values are moderate. The difficulty in using one method of evaluation to the total exclusion of others is noted. The social internal rates of return are lower than the private internal rates of return but the social present values are larger at interest rates below 8%. The social present values show greater responsiveness to interest rate changes than do

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private present values. The possibility of divergence of private and social benefits are also examined.

The analysis includes calculation of pay-back periods and the age by which entry on a program must be made if benefits are to exceed costs. It was found that while pay-back periods were short, the highest age for profitable entry tended to be low because of the high opportunity costs involved for high school graduates contemplating transfer at an older age.

The findings suggest that, since the returns on investment in both programs were not excessive when rates of return and present values are considered along with riskiness of educational involvement, there does not seem to be any need for a large-scale increase in enrolments. The analysis also illustrates the necessity for comparing both private and social benefits as far as possible.

An attempt is made to demonstrate how the findings can be put to use in practical educational planning for the short and medium term and to compare the efficiency of the approach adopted, i.e. the rate of return approach, with other approaches to educational planning.

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CHAPTER I

FOCUS OF THE STUDY

The nineteen sixties witnessed a rapid expansion in the provision of post-secondary education across Canada. The high rates of economic growth stimulated both the demand for, and the supply of educational facilities at the tertiary level. In 1958 - 59 there were 5,433 full-time university students in Albertan universities. By 1969 - 72 there were more than five times as many. Growth in non-university post-secondary education, though not always as spectacular, has still been impressive (Seastone, 1971). It is expected that this sector will increase its share of post-secondary enrolment relative to the university system in the immediate future; the increases in enrolments at community colleges and technical institutes lend some credence to this view. The present study examines one area of non-university post-secondary education, namely the formal training of technologists and technicians in Alberta.

In 1960 the Federal Government passed the Federal Training and Vocational Assistance Act, which was an attempt to reduce the existing deficiencies in the supply of skilled and middle level manpower in the labour force. The traditional flow of technicians and technologists from Euprope to Canada had weakened considerably. Rapid economic growth

in Europe and in the Common Market countries in particular, had increased the demand for skilled labour and concomitantly, had reduced the relative attractiveness of Canadian wages. Canada was thus deprived of an important source of manpower which was not easily substitutable, given the immigration policies then in force.

An added factor in the promulgation of the bill, which was subsequently enacted, was the pervasive feeling that too little had been spent on non-university post-secondary education. The Act, then, was intended to stimulate the development of technical training through cost-sharing arrangements between the provincial and federal Governments.

The creation of the Northern Alberta Institute of Technology (N.A.I.T.) was a direct result of the 'seed' money. This institute and the Southern Alberta Institute are the main educational institutions providing training in the engineering technologies, though there are community colleges whose programs involve some of the training relevant to this field.

Over the last two years, because of the slowing up of economic growth and a relative decline in the demand for labour, there has been some incidence of graduate unemployment, especially for the very highly qualified. The major effect of this problem is that there has been a reduction in the rate of growth of post-secondary enrolments, and at the micro level, there are instances of a decline in total enrolment.

Trends in the labour market have important implications for the planning of education at the post-secondary level in the province, at least for the short-term. The better the job opportunities on graduation, and the more of them there are, the greater the number of prospective students for post-secondary institutions. This determines the demand side of the equation. On the other hand, the supply of post-secondary educational facilities has been determined not solely by student demand, but also by prevailing norms of social welfare, and by the provincial government's utility function. The equating of demand and supply therefore involves both private and social objectives some of which will be examined later.

An important parameter must be noted here. The expansion of the Alberta educational system during the 1960's was facilitated by the rapid growth of the provincial economy over the period (Seastone, 1971). However, education constitutes a major burden on the public purse mainly because it has consistently maintained a high labour intensity. The stringency created through economic policies to control inflation, the restiveness of the tax-payer, and the growing incidence of graduate unemployment have forced governments to be more wary with respect to educational expenditures. Educational planners and administrators are being increasingly called upon to justify expenditures in economic terms.

While there are important social goals which education must fulfill, the economic calculus must now be included in the selection of programs and the allocation of funds. Some would argue that the non-economic goals are by far more important than the economic, and that any attempt to subject parts of the educational system to economic criteria of acceptability smacks of the perversion characteristic of the efficiency cult in the U.S. during the first third of the present century (Callahan, 1962).

Such fears are by no means groundless. However, the programs that are examined here, are oriented specifically to the labour market, to the needs of industry and of government for manpower with specific skills and training. Since market conditions prompted the establishment of these programs and continue to influence decisions of students embarking on a career, nothing is lost by examining the programs from an economic perspective.

The orientation of education planning in the province in the recent past is characteristic of the social demand approach. This method entails only a passive involvement of planners in the provision of places. Student applications for entry are the main criterion for planning, usually done on an ad hoc basis. Longer term planning consists in the extrapolation of trends based on existing enrolments. Such an orientation is consistent with a political ideology that places primacy on individual rights and freedoms.

The increasing incidence of graduate unemployment calls into question the premises of this approach. Educational planners and administrators have to reckon with this phenomenon and will be forced to regulate, or at least, influence the flow of the pipeline in order to avoid the occurrence of costly private and social mistakes. While, in a general sense, students are rational in their choices, their responses are likely to be slow. Planning, supported by a sophisticated information and counselling service, would promote flexibility and eradicate bottlenecks both in the educational system and in the labour market without serious encroachment on the fundamental rights of individuals (Lester, 1966).

A major premise of the study is that, in education, where both economic and non-economic objectives are highly implicated, policy-makers, administrators and those responsible for counselling students, should be fully informed on those aspects of the system that are amenable to quantification. The calculation of the economic benefits does not absolve the administrator of the duty of passing judgment on the non-economic benefits.

CHAPTER II

STATEMENT OF PROBLEM

The major objective of the present study is to quantify in monetary terms the net private benefits of educational programs in the engineering technologies to males, aged 18, and the net benefits to society on its investment in these programs. Analytically this research objective is approached through:

(a) the derivation of private and social costs of one-year and two-year programs;

(b) the derivation of prospective earnings streams for graduates based on 1971 cross-sectional data;

(c) comparisons among the earnings streams of technologists, of technicians, and of secondary school graduates; and

(d) the computation of internal rates of returns, present values, cost-benefit ratios and pay-back periods on the basis of the comparison in (c).

In the light of the findings, an attempt is made to examine the following sub-problems:

(a) the implications of the findings for students as rational decision-makers and for educational planners engaged in the allocation of resources

and in the formulation of educational policy for the province;

(b) the possibility of divergence between private and social goals in education; and

(c) the utility and relevance of the approach adopted in the analysis to the needs of educational planning in the province, and its efficiency vis a vis other approaches.

DELIMITATIONS

The study is restricted to the net prospective benefits to males aged 18 with high-school diplomas who contemplated a career in the engineering technologies in mid-year 1971. The educational programs considered are as follows:

(1) two-year programs at the Alberta Institutes of Technology leading to the diploma in Engineering Technology which is considered prerequisite for certification by the Alberta Society of Engineering Technologists; and

(2) one-year programs at the Alberta Institutes of Technology leading to the certificate in Engineering Technology which is required for certification as an Engineering Technician.

The earnings data for technologists and technicians were derived solely from the 1971 annual survey of the Alberta Society of Engineering Technologists. Data for secondary

school graduates were derived from a country-wide survey undertaken by the Dominion Bureau of Statistics in 1967, the results of which were updated to mid-year 1971 which is the focal period of the analysis. With respect to social benefits, the province rather than the nation, is used as the unit of analysis.

ASSUMPTIONS

The following is a list of the basic assumptions of the analytical procedures applied in the study.

(1) A major assumption of the study is that education is a form of investment and must be subjected to the same criteria as other forms of investment. Inherent in this assumption are the following premises:

(a) students are rational and attempt to maximise the returns on their investments of time and money on an educational program;

(b) the provincial government, as the guardian of society's interests, seeks to maximise the monetary returns on investment on education, even when other social goals are involved;

(c) in the private case, an individual's earnings are determined by his productivity which in turn is determined by his embodied educational stock--his total educational and training experiences;

(d) a correlate of (c) is that increases in earnings

are a function of age and/or experience; non-economic factors, such as race and social class, and economic factors like monopoly power or unionization, are assumed to be inconsequential in determining the earnings of an individual;

(e) in the social case, the before-tax earnings of an individual are indicative of his social productivity or of his net contribution to society's economic welfare.

(2) Cross-sectional data are reliable indicators of prospective earnings streams. It is assumed that the present earnings ratios between technicians, technologists and other occupational groups would remain constant for the immediate future and that present profiles can be used for extrapolation into the future. This assumption is defensible more on practical than on theoretical grounds. However it is the only method available given our inability to make perfect predictions of the future.

(3) The rate of return approach is an efficient tool for the analysis of educational investment.

LIMITATIONS

(1) The data on ages and earnings are derived from a sample survey on the members of the Alberta Society of Engineering Technologists. The membership of the Society constitutes only a proportion of all technologists and technicians practising in the province. The sample may be biased therefore.

(2) The earnings data for the comparative group, secondary school graduates, are derived from the 1967 D.B.S. survey for Canada. The up-dated estimates may diverge from the actual therefore. Secondly, the Alberta secondary school graduates might have had higher salaries than the average for the secondary school graduates throughout the nation.

(3) No attempt is made to include other factors, that can influence earnings-- size of firm, rural-urban differences and post-graduation training.

(4) The private and social monetary benefits do not include the total benefits in welfare terms.

(5) It is assumed that maximisation of monetary benefits is one of the primary goals of educational investment. Both society and students, as individuals, may have other goals.

(6) With respect to social costs, no examination is made of the internal operation of the institutes. The monetary benefits of a program can improve by increasing the benefits but also by decreasing the costs.

(7) It is assumed that marginal social costs and average social costs are equal. If the former are lower and falling, increases in enrolments can result in a reduction in cost per student place which in turn would have a favourable influence on benefits.

SIGNIFICANCE OF THE STUDY

Most of the limited research on the returns to higher education in Canada has been devoted almost exclusively to University types of preparation. The decline in enrolments, or, at least in the rate of increase in enrolments in Universities has been due in part to the emergence of other types of post-secondary education--community colleges and institutes of technology. There is even evidence of a direct transfer of university students to the specific job-oriented programs offered at the institutes of technology. However there has been little research on the returns to these programs. The fact that they are likely to play an ever-increasing role in the post-secondary education sector suggests that too little research attention has been devoted to them. The present study should compensate for this lacuna.

The orientation of the analysis is principally towards the needs of educational planning in practice. Rate of return studies have tended to be concerned, almost exclusively, with determining the actual profitability of educational investments with only superficial treatment of the applicability of findings in continuing educational planning. An attempt is made here to illustrate how the results can be put to use in a planning exercise. Thus the study should be useful both to private individuals contemplating investment in education and also to educational policy-makers concerned with the distribution of scarcer resources among competing goals.

Finally, the study will increase the 'stock of knowledge' on the returns to education in Alberta. Dibski (1970), Wallace (1970) and Wilson (1970) have examined one aspect of post-secondary sector in Alberta. The present study focuses on another area of it.

CHAPTER III

ECONOMIC APPROACHES TO EDUCATION

The present chapter is devoted to discussion of the theoretical and methodological issues involved in the treatment of education as a form of investment and their implications for educational planning. Two major approaches are examined along with some empirical research that has been done in the area.

HISTORICAL BACKGROUND

The Economics of Education, here regarded as embracing most aspects of educational and manpower planning, is a relatively new field of scientific interest which emerged into prominence during the last decade. While the role of human capital in economic growth was well appreciated by the classical economists, the empirical application of the concept of capital to man is of very recent vintage, stemming principally from the failure of models, based on capital-output analysis, to explain growth, and from the post-war discrepancy in the development experiences of the war-ravaged countries of Western Europe, and of Japan, vis à vis the underdeveloped countries which, in spite of massive injections of physical capital, have shown, with a few exceptions, very limited economic dynamism.

In the developed countries, especially in the U.S., macro-economic studies were reporting growth in total productivity far out of proportion to growth in input indices, thus leaving an unaccountable 'residual.' Schultz (1961) and Denison (1962) were two of the first to examine the factors implicated with the 'residual.' In apportioning out the increased product attributable to the various factors of production, they illustrated the impact of the accretion in the educational stock embodied in the labour force. Bowen (1963) suggested that about 80% of the increased output per unit of labour input could be attributed to the residual factors like education, advances in knowledge and improved health care.

Johnson (1964) has argued that the concept of capital should be broadened to include 'anything that yields a stream of income over time' (Johnson, 221). This new orientation set the stage for the analysis of improved health and educational facilities and of other social services as different forms of capital accumulation. The traditional distinction in economic growth theory between homogeneous labour and capital became untenable. The European countries and Japan were able to achieve rapid economic recovery after the war because their human capital was not heavily depleted. In the underdeveloped countries, on the other hand, growth rates remained low even though physical capital was not always lacking because there was an absence of the complementary educational stock.

The formulation of the human capital model provided the basis for studies of a more disaggregated nature than the macro-economic approaches which first suggested the importance of the residual factors in economic growth. Rate of return studies focused on the contribution of different types of educational investment to the national economy and to the distribution of income. The integration of education investment into capital theory meant that the determination of the quantum of resources to be devoted to the sector became a function of the prospective returns to individuals and to society at large. It also meant that educational administrators have to reassess educational objectives from a new perspective (Bowman, 1962).

Education as Consumption

An intractable problem asserts itself when one applies investment analysis to education because of the presence of important consumption benefits. Individuals derive psychic benefits in the very process of education in addition to the longer term enjoyment that comes from sheer knowledge of one's world; the latter is similar, conceptually, to the benefits of durable consumer goods. The implications of these 'non-economic' benefits are that while the individual may assess the returns on his educational investment primarily in monetary terms, he may be influenced also by the psychic returns of the educational process of his post-training activities. In professions like the clergy, where returns

may appear low, there may be compensating consumption benefits which render them just as appealing to the individual as professions with higher monetary returns. The social correlate of these non-monetary private benefits can be found in the promotion by governments of 'cultural enrichment' programs, the purpose of which is not to raise productivity but rather to appeal to the aesthetic. It is practically impossible to attach money values to such benefits.

Education and Social Demand

Another aspect of the consumption problem is that the social demand for education tends to be self-generating (Bowman, 1963 and Stone, 1964). The more universal high school graduation is, the more necessary it becomes for the job-seeker. Social norms, rather than functional requirements, may render some form of post-secondary education obligatory for most workers. The fact is that this secular rise in standards in the level of education of the labour force is not necessarily accompanied by a correlative increase in productivity; there is no reason to believe that a taxi-driver with a university degree would be far more productive than a secondary school graduate. Thus some proportion of the overall increase in educational standards can be assigned to the consumption rather than the productivity balance sheet.

In applying the investment analogy to education, one must bear in mind that efficiency is not the only, or even the most important social goal in the provision of some types of education. Redistributive justice and equity goals do

influence such provision. Although efficiency criteria may suggest otherwise, society or the governing élite may feel the need to ensure that certain target groups achieve minimum levels of education (Weisbrod, 1970). Post-secondary education for the lower classes may contribute to the weakening of social class barriers and to the promotion of social mobility in the society. In sum, education produces consumption benefits which are not amenable to quantification except in ordinal terms, and at the margin, one may want to weigh immediate consumption benefits against the financial yield on the investment.

THE APPROACHES

Given its pivotal role in economic growth, economists have examined educational investment in terms not only of its private returns but also of its contribution to overall growth rates. The new fields of manpower planning and educational planning have emerged as adjuncts to economic development planning. There is, however, great controversy as to the methods that should be used in planning accretions in the stock of human capital. In a sense the differing approaches reflect ideological orientations. More importantly, they are the natural sequel of the attempt of economists, engaged with the divergent growth problems of developed and developing countries, to fashion relevant tools of analysis. Two approaches will be discussed here, namely,

the manpower requirements approach, and

the cost-benefit approach.

Manpower Requirements Approach

Until lately this was very much in vogue in the less developed countries for whose needs most of them were developed. During the 1960's planners in the emerging countries, which were seeking to marshall all their resources for development purposes, recognised the importance of integrating economic development, educational, and manpower plans. Basically, manpower and educational plans attempt to outline the manpower requirements that must be fulfilled if certain economic and social targets are to be achieved. The educational plan subsumes a manpower plan, which in turn subsumes an economic development plan, all presumably internally and mutually consistent. The models part company, however, in their methods of arriving at this consistency.

One of the earliest models is the Harbison-Myers approach. Harbison and Myers (1964) developed what they called a composite index, which distinguished among countries on the basis of their level of human resource development. They found that the following were highly correlated with G.N.P. per capita.

(a) enrolment at the secondary level as a percentage of the age group 15 to 19 adjusted for length of schooling, and

(b) post-secondary enrollment as a percentage of the age group 20 to 24 and multiplied by a factor of 5 to reflect the relative importance of post-secondary education over secondary.

Their arguments imply that if a country wants to achieve the per capita income of country X, it ought to develop the same sort of manpower resources as country X.

Sen (1966) and Bowman (1966) have pointed out the inherent confusion of stock and flow concepts in the Harbison-Myers approach. The level of economic development of a country is determined by the stock of manpower now in the labour force and not by the number of students flowing through the educational pipeline, which in fact may be functionally more related to the consumption needs of the society; a richer society is better able to send large numbers of its people to school. In practical applications, the approach can produce some absurd results, as Rado and Jolly (1965) found in a case study of Uganda.

The Tinbergen-Bos model is one of the more sophisticated approaches to educational and manpower planning. It assumes a relationship between economic development and education given that:

(1) economic activity requires a stock of qualified manpower since the flow of new graduates from the educational system represents only a small proportion of the total stock,

(2) the structure of the educational system shows high degree of interdependence among its parts since the expansion at any level is conditional on the expansion at a lower level and sometimes at a higher level too, as in the case of

teacher-supply and the expansion of primary and secondary education. In fact the education sector uses a significant proportion of its own output, and,

(3) qualified manpower can be imported.

Their model is of the input-output type, explicitly assuming away the effects of supply and demand on the price of manpower. Their aim is 'to describe the demand flows for various types of qualified manpower to be expected from the organizers of production and of education' (Tinbergen and Bos, 1964 :148). The authors assume that ways and means can be found to induce the population to seek desirable education and also to enlist the commitment of educated manpower. This latter point characterises most of the planning models. Jolly (1968) even suggests that finance is not a major issue in educational and manpower planning if the right labour policies, including wages and income policies, are developed.

The Tinbergen-Bos model explicitly includes the volume and rate of increases in production in the system of equations, linking the economy and the educational system. The authors argue that the ideal growth-path of the educational system is one of the regular and complementary development congruent with the desired growth of the economy. In other words, they regard the planning process as one of ensuring balanced growth of the educational system and the economy given the structural relations outlined. They illustrate the effects of different growth rates in output on the educational sector and outline

the transition problems of growth that can arise when some of the equations cannot be fulfilled. For example, there may be far fewer graduates than needed if the economy is growing at 6% per annum whilst enrolments are increasing at the same time. Where there is a short-fall in manpower, such policy variables as self-help schemes and foreign technical assistance can be called upon to make the system of equations determinate. They follow through the constraints on localisation schemes where planners accept certain economic targets over some chosen time period.

Using a two sector model they demonstrate effects of such factors as drop-out, retirement, increasing the number of educational processes in the system, using smaller time units, and the elimination of surplus manpower. The basic model with a number of refinements was applied to Spain, Turkey, and Greece, and was considered very malleable to the needs of educational and manpower planning in those countries.

One of the off-shoots of the analyses of Tinbergen and Bos was the discovery of a high coefficient of determination for the regression of third-level manpower and the volume of production in international cross-section data. Rado and Jolly (1965) apply the derived coefficients in a planning model for Uganda. The model is useful since its structure forces the planner to examine the consistency of the various policy or instrument variables. The use of high speed computers allows the introduction of constraints in the derivation of determinate and consistent solutions.

A similar approach is adopted by Parnes (1964). He subscribes to a technological rather than an economic conceptualisation of educational planning. He argues that educational and manpower planners should be concerned not so much with the future demand for manpower as with the conditions that must be fulfilled if targets are to be realized. Plans then are

> not so much predictions of what will happen in the manpower field as indications of what must happen if certain targets for economic growth are to be realized.
>
> (Parnes, 1964:75)

Thus a given level of productivity in a branch of activity dictates the required technology, the manpower structure or functional composition of the work force.

Weaknesses of Planning Models

(a) Manpower growth paths:

Hollister (1965) has attacked some of the assumptions of the manpower forecasting models and has outlined the restrictive conditions that must hold if these models are to be applicable. In the first place it must be assumed that each stage of economic development has its own peculiar structure of demand for goods and services and that as a correlate, all economies will experience similar manpower growth-paths. This is the implication of the function derived from cross-section data.

Another fact is that although the models may attempt to adjust for productivity changes among sectors over time,

the rates of change in productivity vary substantially over time. Thus the industrial sector may grow much faster in one period than another and this has implications for manpower utilization.

(b) Substitution:

Perhaps the most important criticism, made by Hollister (1965) and also by Blaug (1967) and Bowman and Anderson (1967), is that the forecasting models fail to reckon not only with substitution possibilities among different types of manpower but also between manpower and capital. The ideal situation for manpower and educational planning purposes is one where there is zero elasticity of substitution among skills and among educational categories.

> When elasticities of substitution are low, observed occupational coefficients provide a good basis for projections since they are not the result of supply conditions . . . but are technologically determined.
>
> (Hollister, 1965:91)

This assumption induces manpower forecasters to ignore such factors as the relative costs of the skills to total costs of production, the responsiveness in prices of the goods produced by the workers, and the substitutability among skills and different substitution possibilities among sectors using the skill.

(c) Political bias:

One further criticism of the manpower forecast method is that it has an anti-democratic bias. Bowman and Anderson (1967) argue that manpower planning of the type outlined

impinges on the individual right to choose a carrer and

> societies at every level need to be aware of the risks of controlling individuals' choices of careers by means other than salary structures,
>
> (Bowman and Anderson, 1967:21)

Although one may agree with this assertion, the growing complexity of modern society may entail the giving up of some of one's rights. The individual who is allowed to make mistakes may become a charge on society in terms of unemployment and welfare benefits. The current discussion in Canada on the advisability of making welfare and other grants to the unemployed, conditional on their enrolment in training programs is illustrative of the conflict between the rights of the individual and the social goal of a full employment economy.

(d) Disaggregation:

The model is not particularly useful for planning at a disaggregated level. In a decentralised system of educational financing it would lead to serious errors. Inherent in its use is the assumption that unless the planner can regard the entire country as his universe, he cannot draw up any consistent plans. Thus while the model may be useful in arriving at a first approximation at the aggregate level, its application is very restricted at the local level.

A canadian manpower plan. There is a recent Canadian study that employed the manpower forecasting approach. Ahamad (1969) based national projections of the occupational structure

structure of each industry on the simple extrapolation of the structure observed in the census years 1941, 1951, and 1961. He assumed that past trends in demand and output would continue though he made allowances for changes in the composition of demand. The projection of requirements was based on

(a) occupational employment as a proportion of total employment,

(b) total employment per unit of output, and

(c) the level of output of each industry.

He assumed that the economy would be operating at its optimum in 1975 and that output would grow fastest in the secondary and tertiary sectors, while productivity growth would be greatest in the primary sector. Using two different sets of assumptions he tested the sensitivity of his estimates and developed a range of 'plausible' estimates. His projections show a decline in the importance of primary occupations--farmers, farmworkers and trappers--and a decline in the percentage of labourers. Professional and technical occupations were projected to increase their share of total employment to about 16%, the largest for any group. Ahamad's study suffers from the weaknesses that have been outlined above. The manpower requirements and, by implication, the training needs, for a country that is rapidly changing from being an exporter of primary products to an exporter of sophisticated manufactured products, cannot be based on the extrapolation of occupational structures in previous time periods.

THE RATE OF RETURN APPROACH

The term rate of return is a global one, and includes three different methods of reporting profitability of an investment: (a) internal rate of return, (b) cost-benefit ratio, and (c) the present value method.* This approach involves the explicit assessment of education in terms of investment analysis. Human capital is subjected to the same analytical criteria as other forms of capital. From a society's perspective, investment in education should be undertaken until the marginal returns on such investment are equal to the marginal costs. The actual size of the returns and costs depends on the rate of interest that is used in comparing the time-shapes of both costs and benefits streams. In the private case, individuals endeavour to maximise their net lifetime returns by investing in their own education to the point where the marginal investment costs are equal to the marginal benefits.

In perfect labour markets, where there are no constraints on inter-occupational mobility, occupations which are yielding high returns at one point in time, would cause the transfer of individuals from the less to more profitable educational and training programs. The flood of applicants and of new graduates will increase the competition for available jobs and will cause a decrease in the rate of return since employers will be less inclined to raise wages and

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*The methods are outlined in Chapter IV.

salaries if there is a pool of the particular manpower from which to choose. Employment prospects for most Ph.D's during the nineteen-sixties up to the present, have demonstrated some aspects of the perfect competition model. The situation has changed from a seller's to a buyer's market for some types of positions.

Rates of Return and Forecasting

The rate of return approach does not forecast the future demand and supply of manpower. It merely shows how the two are matched at a particular point in time (Blaug, 1967). However this is the information on which planning should be based. Inordinately high rates of return would prompt the planner to examine for bottlenecks in supply. It is usually necessary to expand enrolments in the particular field if the rates are to be reduced or are to stabilize around the 'normal' rate of interest. Unemployment rates and average starting salaries are reliable indicators of the turn the market is taking. Rates of return slightly above average may call for marginal adjustments, if any at all, in enrolments. Very high rates, on the other hand, are likely to call for substantial increases in the short-run.

In the calculation of the rates of return the method that is frequently employed is to observe for a chosen year the before-tax earning differentials that are associated with varying levels of education, and then to calculate the internal rate of return that would equate the present value of the expected life-time differentials to the costs incurred in

undertaking such education. With respect to an occupational or educational category, a cross-section of age and/or experience and earnings is used to derive a benefit stream or earnings function which, when compared with the costs of the education, indicates the profitability of the investment (Weiss, 1971). This rate, or the present value and cost-benefit ratio calculated at going rates of interest can be used to compare the educational investment with other forms of investment.

Intervening variables. Becker (1964) has given theoretical and empirical treatment to the major factors involved in human capital analysis: the effects of multi-period investments, of secular changes in wage differentials, of risk and liquidity, the decline in mortality inter-generationally, of capital markets for educational investment, and of imperfect knowledge among students, are all considered. Mincer (1962) has given particular attention to the returns from on-the-job training, specific and general training, and discusses the burden of costs on employers and trainees, and the effect of specific on-the-job training on employment patterns.

Albin (1970), using a similar theoretical model, has looked at the negative distributional impact of unbalanced growth on the accretion of human capital among the poor. Since the poor may totally lack funds for education and constitute a much higher risk with respect to educational investment, higher rates of interest would be required in

their private financing of education. On the other hand, most jobs in the progressive sector of the economy demand a certain educational requirement. Thus poor people tend to remain locked in a vicious circle of poverty. Hansen and Weisbrod (1969) also, have examined the distributional impact of higher education in California. So large has been the volume of literature devoted to various aspects of rate of return on human resources that a recent bibliography by Wood and Campbell (1970) lists almost four hundred publications, either directly or indirectly related to this field.

Weaknesses of rate of return approach. The major problems involved in the use of the rate of return approach have to do with the underlying assumptions.

(a) Earnings and productivity:

It is assumed that graduates of an educational system receive returns commensurate with their marginal productivities which in turn are functionally related to their level of education and training. We have already noted the problem posed by the secular improvements in the level of education in labour force, improvements which may have more relevance for consumption rather than for investment analysis. What is important here is that the assumption that earnings and salaries of workers are true indicators of their contribution to G.N.P. is open to question.

Market power and social norms and conventions can cause the two to diverge. Kershaw and McKean (1962) have demonstrated

this fact in their discussion of fixed salary schedules for the teaching profession. In the early sixties, when the demand for scientific personel in the U.S. was very high, school systems were unable to recruit science and mathematics teachers in sufficient numbers. Graduates in Mathematics and the Sciences were finding better paying positions in industry and in defense, while, as teachers, they received the same salaries as teachers in fields in which there was no shortage of applicants.

The social norm of equal pay for 'equal' work resulted in a shortage of teachers in the Mathematics-Science field while it encouraged an oversupply in other fields. School boards raised their salary schedules with the purpose of enticing graduates in Mathematics and Science. At the same time the returns to graduates in the fields with excess supply seemed very attractive given the higher schedules.

Another example of this perverse relationship between supply and demand resulting from institutional arrangements is found in ex-colonies. Earnings are often a function of the pre-existent colonial salary scale which was formulated when it was necessary to attract personnel from the metropolitan area. In spite of localisation of posts, and in some cases a surplus of high-level manpower the colonial salary schedule is closely adhered to.

(b) Maximisation of monetary returns:

It is assumed that the individuals, in the private case, and society, in the socail case, are concerned solely

with the maximisation of the monetary returns from an educational investment. Admittedly, this is not the only goal of education. The state may have other goals than simply ensuring efficiency of its educational investments. Education can promote equity in society and the determination of the quantum of resources to be devoted to the sector cannot be determined solely on efficiency grounds. The promotion of one goal can have negative effects on the achievement of the other. Training programs for blacks in the U.S., and for natives in Canada, may have essentially redistributive objectives--to enhance the long-run earning capacity of the groups and to break the vicious circle that locks a group in poverty from generation to generation.

Applying normal economic criteria, with a short time horizon, may lead to the conclusion that it is sounder to invest in educating the children of suburbia since the probability of their successful completion of a course of study is higher and the returns are likely to be higher. In short, where equity goals are considered equally important, planners should apply a rate of interest lower than the prevailing interest rate, i.e. a lower rate of discount is applied to net benefits, given that the lower the rate, the higher the present value of the benefits.

As was argued above, provided the monetary factors are not considered as the only criterion for the acceptability of an educational program, this assumption is not restrictive. The use of cost-effectiveness analysis to assess the

contribution of the educational system to societal non-economic goals can correct for possible biases in the rate of return approach. The problem is more difficult in the private case, for psychic returns to the individual are not measurable. However, since, given the relevant abilities, students on the whole seem to opt for the best paying professions, evident in any comparison of applications to faculties of medicine as against departments of classics, the monetary factor is sufficiently important for analysis.

It must be remembered also that inconsistencies can arise in relating private and social benefits. The problem is that while education produces benefits for the individual and society, these need not be coterminous nor commensurate but may actually diverge. The presence of external or spillover effects have to be considered. This is another area where the value judgments of planners must intercede.

(c) Cross-sectional earnings and life-time earnings:

Cross-sectional earnings may not be good indicators of life-time earnings. As the level of education rises, the relationship of wages among different types of manpower can change, and thus can create a downward or upward bias in returns estimated from cross-sectional data. Becker (1964) has stressed the importance of examining both wage ratios and wage differences.

> Clearly a secular decline in wage ratios would not be inconsistent with a secular increase in real wage differences if average wages were rising, and indeed, one important body of data on wages shows a decline in ratios and an even stronger rise in differences.
>
> (Becker 1964:54)

Bowles (1970) using a constant elasticity framework on international cross-section data has found evidence to suggest that there exists a high elasticity of substitution among labour categories. Such a thesis suggests that a university graduate would be worth the same number of secondary school graduates to an employer from one time period to another.

The emergence of graduate unemployment may lead one to question this argument. University graduates are now forced to take jobs that were previously reserved for high school graduates and thus their average returns are reduced. Yet one should note that if university graduates set their sights lower, secondary school graduates would face worsening prospects since they must compete with more highly educated personnel. The decline in their returns as a result of unemployment and lower job opportunities relatively, would help to maintain some constancy in the ratio of salaries of university to secondary school graduates.

It must be noted that since foregone earnings constitute the major component of private educational costs, the fall in earnings of secondary school graduates, resulting from increased unemployment and greater competition from highly qualified manpower, has the effect of reducing the

foregone earnings cost component to the prospective student. Salary ratios can remain relatively constant over time (Becker, 1964).

Blaug (1965) has admitted that the use of cross-sectional data may lead to biases. He argues that such data form the basis for private investment decisions and provided one estimates correctly for the immediate future--five to ten years-- significant shifts in earning patterns in the latter part of the individual's working life would not affect the results substantially since the discounted differentials far into the future would be very small relative to differentials in the immediate future. This need not always be true especially in cases where comparisons are made among professions with differently shaped profiles.

(d) The treatment of unemployment:

One important factor that has sometimes been overlooked in rate of return analysis, is that unless an adjustment is made for unemployment, rates of return can be misleading. Thus a high rate of return can be reduced to a normal rate when unemployment is taken into account. There has been some important research in the United States on job search and unemployment (Alchian, 1970). Leibenstein (1964) and Todaro (1969) have argued that the rational unemployed worker may choose to remain unemployed if his expected wages are high relative to the immediate offers by employers.

This 'gambling' effect is relevant in rate of return analysis. If, in spite of the existence of a pool of

unemployed, salaries in an occupation show no downward adjustments, unemployed workers with the necessary training would not beat wages down but would engage in extensive job search, gambling that they would find one such job at the existing salary scale. This probabilistic factor explains the apparent irrational behaviour in the manpower field when high private demand for higher education co-exists with graduate unemployment and rural-urban migration with high urban unemployment. Given unemployment, the actual rate of return is lower than suggested by current salaries and earnings.

(e) Optimality in distribution of skills:

In the case of social rates of return, it is normally assumed implicitly or explicitly that the present distribution of skilled manpower is optimally allocated and that earnings reflect social marginal productivity of workers. Rado (1967) and Jolly (1967) have contested this point. At the very moment of analysis, the society may not be deploying its manpower optimally. The marginal productivity of some workers may be improved simply by a more rational distribution of the existing manpower among sectors. One indication of maladjustment may be the number of graduates employed in areas for which they were not trained.

In the case of private rates of return, the planner or analyst has to take cognisance of market power. Professional bodies help to keep the returns to their members high by restrictive entry. High private rates of return may be

symptomatic of 'quasi-rent'--the result of a contrived scarcity. It can be argued that most professions require lengthy periods of study and thus the rate of return must be high enough to encourage students to undertake such programs. Given differential bargaining power it becomes difficult to determine what is a reasonable rate of return on purely economic grounds, since questions of equity become pertinent at this point. It is therefore necessary to examine for non-economic factors that may lend an upward bias to the calculated rates of return. Psacharopoulos (1970) has illustrated the use of shadow wage rates to correct for these distortions in the returns to high level manpower in Greece.

(f) The scale of investment:

One weakness of the rate of return approach in social planning concerns the range over which the results apply. It is a highly servicable instrument when one is examining marginal changes. Prest and Turvey (1965) and Merrett (1966) are doubtful of its utility when contemplated investments are so large that they are likely to alter the relative prices of factors. Educational planners would be hard-put to calculate a rate of return to post-secondary education where enrolments are to be doubled over a short period. Non-marginal shifts present difficulties in the calculation of opportunity costs, on the one hand, and future benefits, on the other.

(g) Value premises:

The rate of return approach is sometimes proffered by its proponents as being value-free and thus in some sense

superior to the requirements approach. Chamberlain (1969) challenges this calim, and argues that there are value-premises in the use of rate of return analysis in educational and manpower planning. The value-neutral stance is more imagined than real.

> It would not be too extreme to suggest that the effect of the human capitalists is to channel social investment (and we are particularly interested in investment in education) along the lines which tend to serve those whom the economic system as a whole serves best . . .
>
> (Chamberlain, 1969:238)

He goes on to ask the pointed question:

> If an economist were to begin a cost-benefit analysis of human capital under one government and a revolution occurred while he was in progress, could that economist complete that same analysis under the new government, simply carrying on from where he had started making use of his original data? More specifically, would a cost-benefit analysis of an educational or training program use the same data and reach the same values under a Trujillo as under a Castro?
>
> (Chamberlain, 1969:239)

While one may agree that the approach is not value-free, one can argue, equally cogently, that scarcity is a fact of life and different societies attach scarcity values to different things over time. The techniques merely involves maximisation of benefits over costs, whatever valuation the government or society attributes to them. And very few revolutions have involved the total and immediate replacement of old values by new ones.

THE RATE OF RETURN APPROACH AND ON-GOING PLANNING

Although the rate of return approach is based on cross-sectional data, its results can be extended over the time through the use of wage functions derived from cross-section data. If one can derive a functional relation showing the relationship between wages and age and/or experience given that for each educational or occupational category the shape of the profile does not change substantially over short periods, it becomes feasible to calculate the rates of return for any year by using indicators--such as average starting salaries--to determine the level of the curve. Data on average starting salaries are more easily collected on an annual basis than data for age-income profiles, which are better collected through census or large scale survey operations.

There is some theoretical merit in the use of starting salaries. Arrow and Capron (1959) have discussed the adjustment process in the demand and supply for engineers and scientists. Firms become aware of changes in market conditions only after a lag. As advertised vacancies find no takers, firms readjust their offers to make them more attractive. But by doing so, there has to be a complementary adjustment within the firms, as employees in the same category put pressure on management to raise their salaries also. Thus a firm which raises its starting salaries for engineers, incurs an increased cost for the eningeers already working with it.

An increase in the demand for a skill, in the absence of high unemployment, would be reflected by an increase in average starting salaries. By analogy, the level of the profile would rise as the starting salary rises. If the latter rises by 5% from year t to year t+1 the level of the curve will rise by 5% in a rapidly adjusting labour market. By comparing the starting salaries from which one derives the total prospective earnings, computing current costs and net benefits, one can easily calculate the rate of return to the particular form of training. The wage functions thus provide educational and manpower planners with an effective tool in making annual adjustments which would take account of changes in the demand situation faced by various skill or educational categories.

Ideally for social decision-making the planner may choose a reserve rate of interest, and through the number of places provided, the supply of graduates with the relevant skills or educational attainments, can be expanded or decreased in such a way that the chosen rate of interest is maintained over time. Even in cases where the planner does not have much control on the supply, counselling services providing comparable information would tend to create a similar process of adjustment of supply and demand. In the latter case, however, the student would not know how many others were making similar decisions. If many more were making the same decision he might find the field flooded with graduates by the time he was ready to enter the labour market.

The rate of return approach is not necessarily inconsistent with the requirements approach. In fact, it can and should be used in assessing the efficiency of the latter. Adelman (1966) and Bowles (1967) have illustrated this for Argentina and Nigeria respectively. Furthermore the approach is ideally suited for sensitivity analysis. So many unknowns are involved in planning and in educational planning in particular, that it is prudent to examine for the effect on one's estimates of changes in the assumptions or parameters in the planning model. Hollister (1964) defines sensitivity analysis thus:

> Sensitivity analysis is carried out simply by taking a key variable parameter or assumption, changing it slightly, and then reworking the estimates to see what effect that change has on the final result and to see how sensitive the results are to change in the selected element.
>
> (Hollister, 1964:163)

In social rate of return analysis, one can vary the rates applied to see what effects they have on the returns to the programs. To draw a statistical analogy, confidence intervals can be derived on the plausibility of different levels of private or social benefits.

Inspite of the attendant constraints, rate of return analysis proves to be a most effective tool in educational planning especially at the micro level where administrators have to operate in decentralised systems most of the time. Although present cross-sectional earnings may not be good indicators of future earnings trends, student choices are made principally on the basis of the former. The decline in

enrolments at Alberta universities attests to students' analysis of the market for university graduates. Information lags reduce the 'reaction speed' of the labour market but responses are still guided by cross-sectional earnings.

At the social level where unquantifiable externalities are thought to exist, planners can make more rational decisions by comparing the known monetary returns with the imputed external benefits. 'Surely it makes more sense to advocate something on non-economic grounds after, and not before, the implications of an economic point of view are clearly understood' (Blaug, 1965:259). The rate of return approach puts educational investments on an equal footing with other forms of investment.

Recent canadian evidence. Most of the empirical research on returns to various forms of education has been done in the United States. The literature on Canada, however, is appallingly limited. One reason for the larger number of American studies is that the 1960 U.S. census data provided a breakdown of age-income groups in categories that allowed researchers to examine for the effects of level of education, race, region, length of residence etc. Hanoch (1965) used 23 explanatory variables in deriving an earnings function. The Canadian census data are less elaborate.

Podoluk's (1965) and Wilkinson's (1966) were some of the first studies using Canadian census data. More recently, there have been studies by Stager (1968) and Dodge and Swan

(1971) on Ontario and by Dibski (1970, Wallace (1970) and Wilson (1970) in Alberta.

Stager (1968) has provided a comprehensive analysis of post-secondary education in Ontario. He examined both the private and social rates of returns to graduates of the Ontario institutions, and also analysed the implications of year round operation of post-secondary institutions. Allowances were made for ability factors, labour force participation, unemployment, sex, taxes and mortality.

He found that the net monetary returns to most forms of post-secondary education in Ontario were higher than those reported for the United States, Great Britain and Denmark. Two other interesting observations were made. Some earnings streams did not show the 'single-hump' shape normally expected in age-earnings profiles. There was only a marginal private advantage from year round operation of post-secondary institutions and the social return was slightly higher.

Wallace (1970) has examined the returns to individuals who transferred from certain trades to teaching. Throughout the 1960's the provincial government had encouraged such transfers in order to meet the need for industrial and vocational education teachers at the high schools. This was another aspect of the Act which stimulated the development of institutes of technology. Most of the teacher-trainees for the Bachelor's degree in Vocational Education were selected from the trades. Wallace (1970) examined the benefits to two male occupations, automotive mechanics and

TABLE I

PRIVATE RATES OF RETURN TO EDUCATION BEYOND HIGH SCHOOL, ONTARIO, 1961

	Internal Rate of Return
Dentistry	30.2%
Medicine	18.0
Commerce and Business Administration	19.0
Education	10.1
Physical and Health Education	10.1
Social Work	0.3
Law	13.8
Technologies	12.9

Source: Table IV:3, Stager, 1968.

construction electricians and two female occupations, stenographers and beauticians.

The transfer for the females showed extremely large monetary returns; for males in the automotive field the benefits outweighed the costs provided they entered on the program before age 38. The returns to construction electricians were of a lower order of magnitude. One important factor that was responsible for the high returns was the level of financial assistance that was provided to most of the students during their first year of study. The costs to the student were substantially reduced by these allowances. Wallace, however, did not examine the social monetary returns.

Dibski (1970), employing a similar methodology, looked at the returns to different forms of teacher education under various assumptions about age, teaching experience and number of years of teacher education. Using a reservation rate of 8% he finds that three or four-year programs of teacher education were financially profitable for Albertan males provided they began their studies by age twenty-five. For females, however, the programs were attractive under most of the assumptions. The internal rates were above 20% in many cases. As expected, the pay-back period was very short for females.

Wilson (1970) compared returns to four-year Engineering, three-year Arts or Science and four-year teacher education programs. For males aged 18, with benefits

discounted at 8%, Engineering proved to be the most lucrative followed by teacher education and then Arts and Science degrees. Wilson also limited his discussion to private monetary returns. The three studies used cross-sectional data for 1968. It is possible that the findings are not as applicable to the 1972 situation with the presence of unemployment of university graduates in the Canadian labour force.

CHAPTER IV

RESEARCH DESIGN AND METHODOLOGY

The study is devoted to an examination of monetary returns on specific educational programs in terms of the human capital model. The analysis can be divided thus:

(a) examination of the prospective monetary benefits and costs to students who enrolled in programs leading to certification as technologists and technicians in Alberta in 1971; and

(b) the prospective monetary benefits and costs to the citizens of Alberta on the educational investments in (a).

ASSUMPTIONS

The major assumptions of the analysis can be classified with respect to private and social decisions and consist of the following:

The Private Case

(a) Students are rational decision-makers.

It is assumed that students are rational in an economic sense and are concerned primarily with the maximization of their net lifetime earnings. Thus psychic benefits are not included here. Monetary factors are the only determinants of their choice of program. Furthermore

they remain in the occupation for which they are trained and do not regard the programs at the schools of technology as preparatory for transfer to unrelated fields or to further education at university level.

(b) The actual cross-section of after-tax earnings in 1971 is a reliable indicator of the stream of lifetime earnings.

Students consider the existing profile as the relevant market situation they would face over their lifetime. It is the only information on which they can base their choices. Although the relative earnings differentials between secondary school graduates and technicians and technologists, and between the latter two, are likely to change over time, it is assumed that the existing ratios remain in force for the foreseeable future. (Becker, 1964).

(c) The students as individuals are not endowed with market power.

It is assumed that students would be perfect competitors within the group of technicians and technologists and are unable to influence the market situation they face. They are price-takers, therefore, and their earnings after graduation are determined solely on the basis of their education and productive capacity.

(d) Average earnings are equal to marginal earnings.

It is assumed that the addition of one extra graduate to the labour force would not result in a significant fall in the average earnings of the group.

The Social Case

(a) Society attempts to maximize the social monetary returns on programs in the educational technologies.

The non-monetary factors are again excluded from the analysis. Thus the estimates cannot be considered as the total social benefits to be derived from the programs.

(b) Students spend their entire working life in Alberta after graduation.

The universe in this case is limited to the province of Alberta. Therefore the concern here is with the prospective returns derived by the residents of the province from social investment in these programs. Some students will take up employment in other provinces and even in other countries. The exclusion of a wastage factor for emigration was prompted by the fact that being one of the richer provinces in a relatively rich country, Alberta will continue to experience net immigration. Implicit in this assumption is that even though a certain proportion of the students are from outside the province the majority will opt to remain in Alberta on graduation.

(c) Before-tax earnings are reliable indicators of social productivity.

The implication of this assumption is that employers pay graduates salaries or wages equal to their contribution to the output of goods and services in the province. A major weakness of this assumption is that in some fields,

e.g. mining and public utilities, the majority of graduates are employed by one or a few major employers. With such limited competition among employers for graduates, the wage rate is determined more by the pre-emptive bargaining power of the former than solely by the productivity of the latter.

The tenability of most of the foregoing assumptions has been examined in the review of the literature in the previous chapter. The flexibility of the approach adopted here, as will be shown later, does admit of the introduction of constraints or limiting assumptions to control for other relevant variables.

METHODOLOGY

The methodology employed is that of the rate of return approach. The three main methods were used in calculating private and social profitability of educational investments.

The Internal Rate of Return

The internal rate of return, r, is defined as that rate of interest that sets the difference between the discounted cost stream and the discounted benefit stream equal to zero. This rate is calculated mechanically by an iterative procedure, i.e., by trial and error. It is derived through the following formula:

$$\sum_{t=0}^{W} \frac{B_t}{(1+r)^{t+1}} = \sum_{t=0}^{m-1} \frac{C_t}{(1+r)^{t+1}}$$

where

B ∿ the net incremental earnings of each group.

t ∿ years of working life.

m ∿ the length of the program in years.

C ∿ costs including direct educational costs and opportunity costs of non-participation in the labour force.

W ∿ the length of working-life with retirement at age 65.

The internal rate can be compared with the going rate of interest. If it is above the going rate the educational investment is considered as profitable.

Opportunity costs are based on the comparative earnings of high school graduates and represent what the student would have earned had he remained in the labour force as a high school graduate.

Benefit-Cost Ratio

The benefit-cost ratio, R, is derived by computing the present value of net returns attributable to the program and dividing by the present value of costs of the investment: both benefits and costs are discounted at some rate of interest, i, where i maybe the rate of interest on government bonds.

$$\left(\sum_{t=0}^{W} \frac{B_t}{(1+i)^{t+1}} \right) \left(\sum_{t=0}^{m-1} \frac{C_t}{(1+i)^{t+1}} \right)^{-1} = R$$

The other variables are the same as above. Where R is less than one the investment is not profitable; costs outweigh benefits.

Present Values

The net present value is computed by subtracting the costs from the benefits rather than dividing the latter by costs as in the benefit-cost method. The net present value, V, is calculated by the following formula:

$$\left(\sum_{t=0}^{W} \frac{B_t}{(1+i)^{t+1}} \right) - \left(\sum_{t=0}^{m-1} \frac{C_t}{(1+i)^{t+1}} \right) = V$$

If V is negative the investment is uneconomical.

The formulae for both private and social returns are the same. However, the definition of some variables differs. In the private case net benefits in each year are based on the after-tax difference in earnings between graduates of institutes of technology and secondary school graduates; opportunity costs are also net of taxes. It is assumed that the individual's decision is guided by the net take-home wage or salary rather than the gross. In the social case, on the other hand, net benefits and opportunity costs derived from earnings of secondary school graduates, are

calculated before taxes. However, they include also the operating costs of the institutes, the sum of which was divided by the total enrolment to derive average social cost per student.

The three methods of calculating returns are used because they sometimes lead to different results in the ranking of investments. Researchers and theorists are not agreed on the most reliable method. Some insist that the internal rate of return is superior to the present-value method. Musgrave (1964) argues that since there are no well-developed capital markets which provide reasonable indicators of the relevant rate of return, the determinant of the feasibility of educational investments is a matter for public policy. Investments should be ranked by the present value method, with priority given to programs with the highest present value.

Stager (1968) used all three methods in his study of post-secondary education in Ontario. He illustrates the fact that the cost-benefit method and the internal rate of return method give a bias to the returns on small projects with high internal rates of return, over the larger projects with high discounted present values. Since education is a long-lived asset, it is suggested, one should use the present-value method.

The three methods are used here not only to maintain comparability between the present study and others but also to examine the effects of rapid obsolescence. Given the rate

of technical change in industry, one cannot discount the probability that some of the existing programs will become irrelevant and obsolete within the working life of a technologist. While experience and initial education may render some training transferable to new skill requirements, the technologists have to reckon with need for retraining after a certain number of years. Thus some investments may have to be partially written off after a limited period. The internal rate of return and the cost-benefit ratio, being more sensitive to early benefits, ought to be retained in this type of analysis (Blaug, 1967).

THE DATA

The data for the study are based on the 1971 income survey of the Alberta Society of Engineering Technologists. This organization, which is closely associated with the Professional Engineers Association, is responsible for the certification of engineering technologists and technicians in the province. It is the third largest organization of the kind in Canada. The Association was formed in 1963 and is a member of the Canadian Council of Engineering Technicians and Tecnhologists.

Since membership in ASET, as it is known for short, is not a requirement for employment as a technologist or technician in Alberta, the society is only a semi-professional organization; membership is entirely voluntary, even though nascent professionalism may prompt technologists and technicians

to become registered. Thus the membership of ASET represents only a sample of the practising technologists and technicians in the province, and there is a probability of bias in extending conclusions to the population. However comparative sample data for Ontario and the U.S. are presented in the appendix which suggest that the Alberta sample is comparable.

PROBLEMS OF DEFINITION

While the term technician has been in general usage the term technologist is not as well known and there is some ambiguity in its usage. There is much overlapping in the functions performed by technologists and engineers and it is argued in some quarters that present curricula for technologists are very similar to curricula for the engineers of yesteryear.

A recent paper by members of the Ontario Association of Certified Engineering Technicians and Technologists provides up-to-date definitions of the terms. The training of an Engineering Technician has a heavy skill orientation with a limited academic component. The latter consists of:

> fundamentals such as mathematics and principles of science and of specialisation subjects which when combined with the 'hands on' skills component, will prepare him to perform the functions expected of him. . . . Normally the Engineering Technician course would represent approximately one year of full time study in a college of Applied Arts. It would be intended as a means of continuing education for students who achieve an average mark of 50% to 60% in grade 12. (Goodings and Wilson 1971:4).

With respect to technologists they state the following:

> The training of the engineering technologist is characterized by a greatly increased academic component and a reduced skills component which is changed somewhat, to accommodate the functions the Engineering Technologist will be expected to perform (Goodings and Wilson 1971:7).

The engineering hierachy therefore consists of the engineer at the top, the technologist, the technician and the tradesman in that order.

One cannot discount the probability that some employers are not fully apprised of the difference between a technician and a technologist, and this would have some effect on the earnings data. However given that most technologists are employed with larger firms and the government, that they are sometimes considered as staff personnel and are more likely to be members of a professional association than of a union as compared to technicians, the lines of differentiation must be faily well-known even among smaller employing establishments.

THE SAMPLE

Almost one thousand two hundred technologists and technicians received the questionnaire. Three hundred and nine technologists and two hundred and sixty seven technicians replied, a response rate of approximately forty six percent. Of the technologists, three hundred replies were usable for the study and of the technicians, two hundred and sixty one. The final sample is therefore smaller than would be adequate for some of the purposes initially contemplated. With larger

numbers in each type of technology, it would have been possible to derive earnings functions for each field of technology separately. Because of the limitations of the data one is forced to work at a highly aggregative level most of the time.

For certification purposes ASET recognizes twenty-two different fields of engineering technology. Three levels of achievement are recognized for both technologists and technicians.

	(1)	Trainee	(1)	Trainee
Technologist	(2)	Technologist	Technician (2)	Technician
	(3)	Senior Technologist	(3)	Senior Technician

For purposes of the present study, no distinction was made among the three levels. While, for example, the Society may credit an individual with the status of Senior Technologist, the employer may not be willing to follow suit. Furthermore the levels are highly correlated with the experience of the individual. Table II gives the number of technologists and technicians by field of specialization. It is evident that the numbers are not evenly distributed across fields.

It is assumed that all technologists have had at least two years of formal training in their field of specialization and technicians have had at least one year of training at an institute of technology. Actually some proportion of the membership of the society would have qualified for certification under the 'grandfather' clause:

TABLE II

DISTRIBUTION OF TECHNOLOGISTS AND TECHNICIANS

BY AREA OF SPECIALIZATION

Field	No. of Technologists	No. of Technicians	Field	No. of Technologists	No. of Technicians
Aeronautical	6	4	Gas	9	11
Agricultural	2	-	Geology	3	3
Architechural	8	6	Geophysical	0	4
Chemical	3	9	Indus. Prod.	1	2
Civil	61	35	Instrumentation	13	6
Communications	5	9	Materials	4	2
Construction	7	15	Mechanical	51	24
Corrosion	-	-	Mettallurgical	2	4
Drafting	32	27	Petroleum	23	28
Electrical	36	21	Power Plant	2	2
Electronic	27	37	Survey	5	12

Source: Annual Survey 1971, Issued by the Alberta Society of Engineering Technologists.

experience and on-the-job training were substituted for the usual academic requirements. If employers regard graduates of the institutes of technology as superior to those who have been certified under the grandfather clause, the average wages of the two groups would differ. It was not possible to control for these factors on the basis of the survey data.

Although the respondents were asked to indicate the year in which they received their diplomas it is difficult to judge how many, who did reply to the question, had diplomas considered the equivalent of those awarded by NAIT and SAIT. Some of the diplomas would have been received in Europe and Britain. In the case of technicians the problem is more acute because only about forty per cent of the latter have received formal training on the basis of the number reporting year of receiving diploma, and these were concentrated in the younger age-groups. Thus on-the-job training has been a more common method of skill acquisition among technicians.

THE COMPARATIVE GROUP

The earnings data for male secondary school graduates, the relevant group for comparative purposes, were derived from a 1967 Survey for Canada, undertaken by the Dominion Bureau of Statistics. The survey results were updated by a factor of 1.34 which was the increase in average weekly earnings for the non-agricultural sector in Alberta over the period June 1967 to mid-year 1971. Table III presents the 1967 and 1971 updated earnings data for high school graduates.

TABLE III

EARNINGS OF MALES, CANADA 1967 AND ALBERTA 1971

Age Groups	Canada 1967			Alberta 1971*
	Secondary Schooling Complete	University Some	University Degree	Secondary Schooling Complete
25 years and Under	3448	2138	3974	4620
25 - 34	6357	6322	8572	8518
35 - 44	7488	8060	12828	10034
45 - 54	7538	9644	14422	10101
55 - 65	7130	9254	13680	9554

Source: Canada, Dominion Bureau of Statistics, Earnings and Work Experience of the 1967 Labour Force, No. 13-535 Vocational (Ottawa: Information Canada, 1971) Table 2.

*The Alberta 1971 estimates were derived by multiplying the 1967 estimates for Canada by an index of 1.34.

A few caveats are in order here. The 1967 survey, like the 1961 census, did not differentiate between secondary school graduates who had, and those who had not completed formal post-secondary education of the non-university type. Thus the earnings for secondary school graduates would be biased upward given the presence of the very group with which we are concerned--technologists and technicians and other personnel whose profession or occupation demands extensive format post-secondary but non-university training, like nursing for example.

Secondly, the use of the index for updating the data carries assumption that the average wages and salaries of high school graduates moved upwards at the same rate as the average for all groups and that the relative position of secondary school graduates in 1971 was the same as in 1967. The numbers of people with completed secondary school education would have increased and it is possible that the labour market situation faced by them would have changed also. However, given that the period is short, it is assumed that the changes, if any, were marginal.

The unemployment statistic used in the study relates to the year 1971 and is taken from the estimates published by the DBS for mid-year 1971. It is assumed that technologists had an unemployment rate one-half the average of 6%. Professional and technical personnel tend to have a lower than average rate of unemployment. The survivorship ratios of the 1961 census were applied to include the effect of mortality

on expected income. Taxes relate to the average tax rates on the personal incomes of single individuals in 1971.

Earnings Function

The earnings data for technologists and technicians, shown on the scatter diagrams, Figures 1 and 2, were obtained from the 1971 Survey of the Alberta Society of Engineering Technologists. It can be seen that there was a sizeable dispersion on the earnings for each age group, for both technologists and technicians. A simple quadratic function relating earnings to age was imposed on the data the implication being that earnings will rise with age up to a point and then would fall beyond that age.

The choice of this procedure over simple linear interpolation between proximate age groups, is that the shape of the profile is smoother without any serious distortions to the data. Furthermore survey or census data reported for single year age-groups are likely to approximate the curvilinear form rather than a linearly interpolated profile.

The curves illustrate the fact that technicians and technologists reach their peak earnings later than secondary school graduates. The peak for the latter is reached about age 46 after which earnings decline rapidly with age. Technicians, on the other hand, reach their peak about age 50 and technologists around age 55. The rate of decline for the latter groups is much lower than in the case of high school graduates.

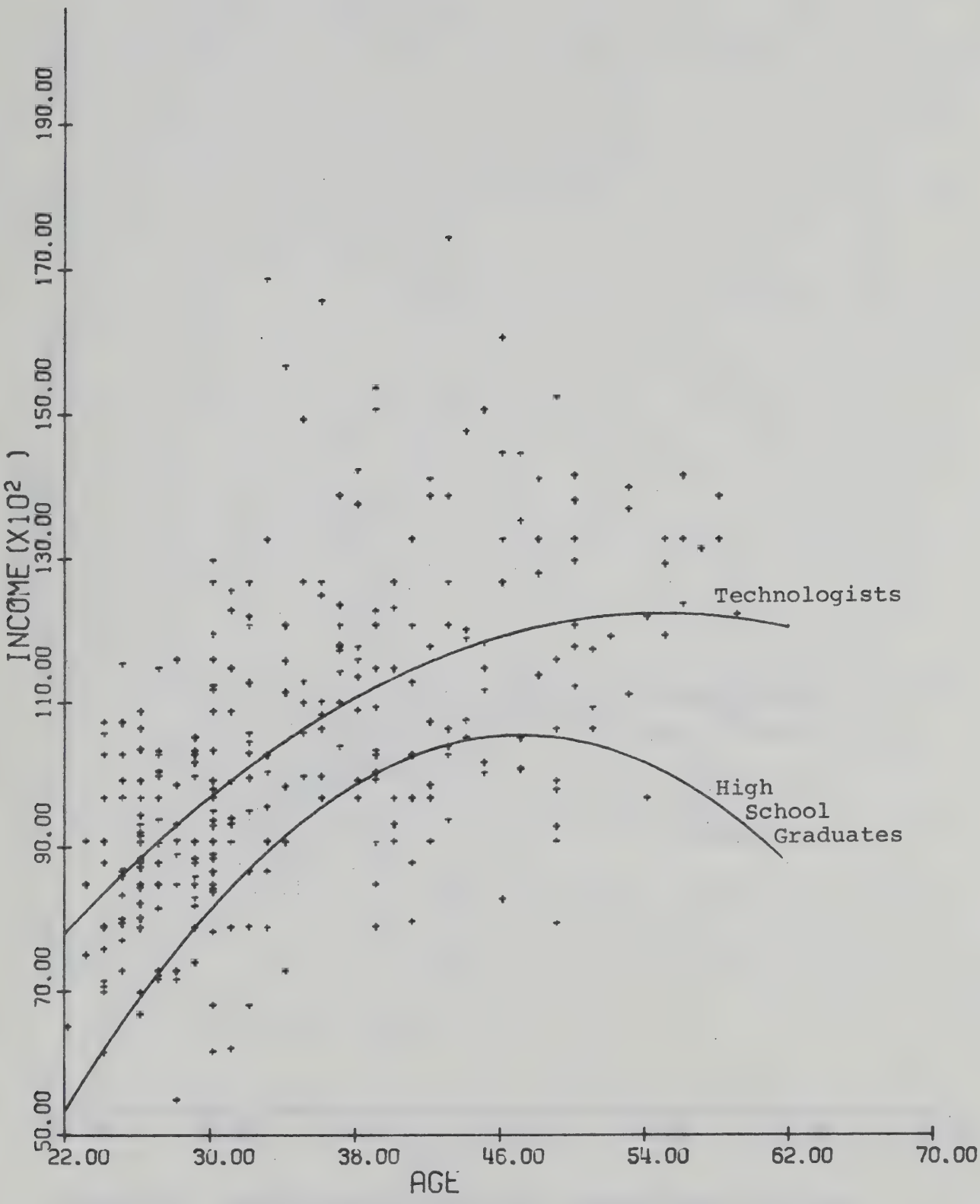

Figure 1: Age-earnings profiles: technologists and high school graduates.

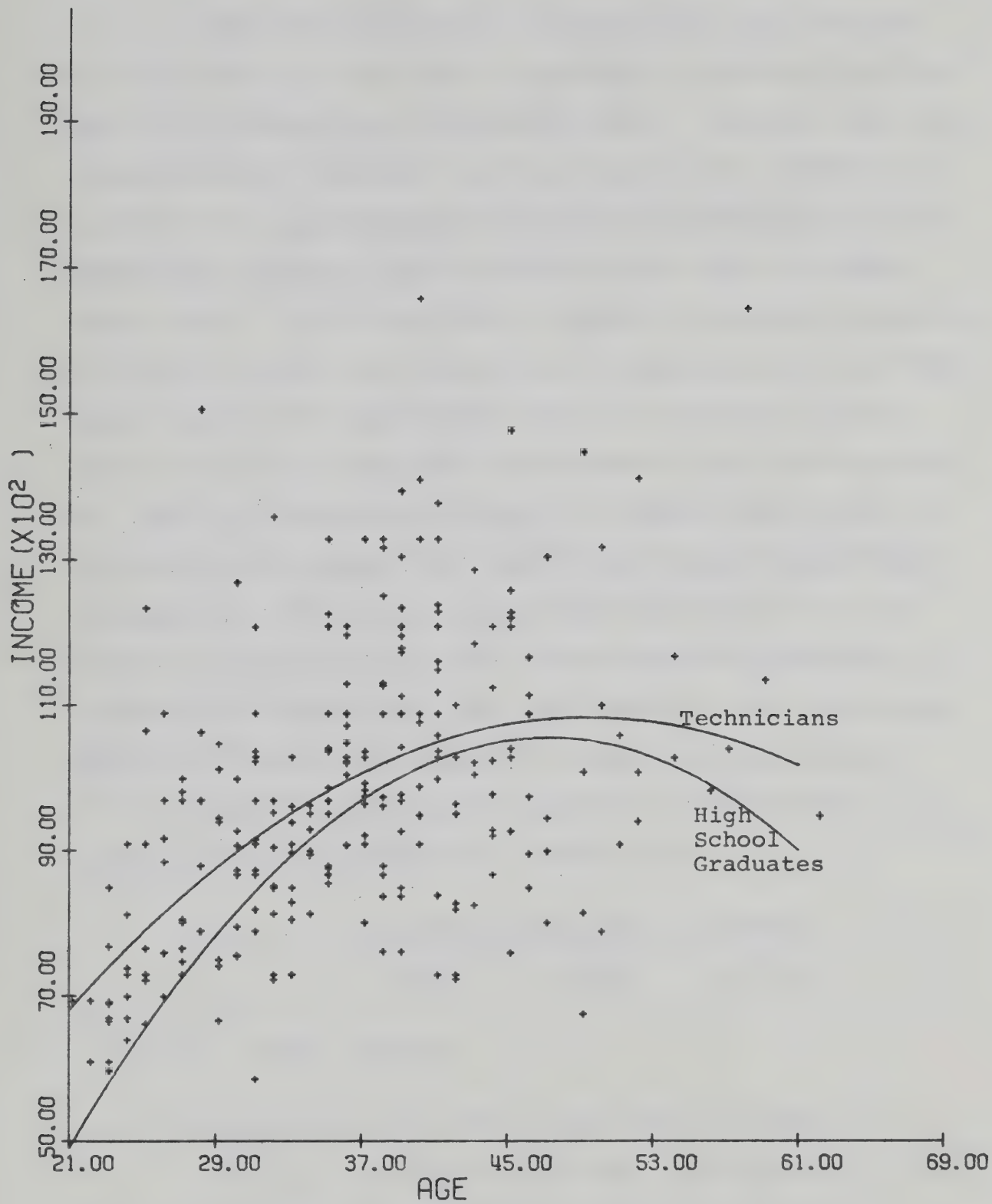

Figure 2: Age-earnings profiles: technicians and high school graduates.

Given the high degree of dispersion, the estimates derived from the curve must be regarded as averages which an enrolling student might have anticipated. Although two highly intercorrolated variables, age and experience, are the most important in explaining the difference in earnings within an educational category other factors do have some influence. Weiss (1971) , in an analysis of returns to graduate education in the U.S. found low coefficients of determination even when such variables as employment status, citizenship, type of work activity and employment were added to age and experience in a multiple regression context. He found coefficients of determination between 0.406 and 0.702, using a logarithmic formulation. The single linear model when applied to the sample yielded an R^2 of 0.342 and he adduced comparative information from Tolles (1964) and Hanoch (1965) indicating that low R^2's are very common in cross-sectional studies.

The following were the equations derived for technologists and technicians respectively:

$$(1) \quad Y = -90.7148 + 448.2620X - 4.0682X^2$$
$$\qquad\qquad (-0.06) \qquad (4.69) \qquad (-3.28)$$

$$R^2 = 0.3506$$

$$(2) \quad Y = -1342.6796 + 492.3279X - 4.9726X^2$$
$$\qquad\qquad (-0.77) \qquad (5.25) \qquad (-4.03)$$

$$R^2 = 0.2703$$

Y is income and X is age. The values in brackets are the t statistics for the relevant coefficients, which are significant at the 5% level, in both cases, for the age variable; the significance of this is that there is a relationship between age and earnings even though there are other intervening variables. The use of these naive wage functions can be defended on the grounds that administrators and educational planners seldom have better data at their disposal and are often forced to resort to cruder approximations.

Because there were no observations for ages 20 and 21 for technologists the average starting salary for Alberta reported by the Department of Manpower and Immigration for 1971 was used as the estimate for graduates aged 20. The estimates derived for the graduates apply from age 23 onwards with earnings for ages 21 and 23 calculated by linear interpolation between earnings for age 20 and age 23. The quadratic formulation was also applied to the estimates for Alberta High School Graduates (Table III) and this yielded the function:

$$(3) \quad Y = -7778.09 + 776.60X - 8.22X^2$$

Table IV shows the estimated earnings for each age group for each level of training.

Direct Private Costs

Direct educational costs to the individual were taken from the calendar of the Northern Alberta Institute of Technology for the year 1971. These costs include fees, books

TABLE IV

ESTIMATED EARNINGS STREAMS FOR MALE HIGH SCHOOL GRADUATES,

TECHNICIANS AND TECHNOLOGISTS IN ALBERTA (1971 DOLLARS)

AVERAGE ANNUAL EARNINGS

Age	Completed High School	Technician	Technologist
18	3540		
19	4012	6234	
20	4468	6515	6600
21	4908	6803	7089
22	5331	7081	7578
23	5737	7350	8067
24	6126	7609	8324
25	6501	7857	8573
26	6859	8096	8814
27	7200	8325	9047
28	7524	8544	9271
29	7832	8753	9488
30	8124	8952	9696
31	8399	9141	9869
32	8658	9320	10088
33	8900	9489	10272
34	9126	9648	10448
35	9335	9797	10615
36	9528	9936	10775
37	9705	10066	10926
38	9865	10185	11069
39	10009	10294	11204

(TABLE IV Continued)

Age	Completed High School	Technician	Technologist
40	10137	10394	11331
41	10248	10383	11450
42	10342	10563	11560
43	10420	10633	11663
44	10482	10692	11757
45	10527	10742	11843
46	10566	10782	11921
47	10568	10812	11991
48	10564	10832	12053
49	10544	10842	12106
50	10507	10842	12152
51	10454	10832	12190
52	10384	10812	12219
53	10298	10782	12240
54	10195	10742	12253
55	10076	10693	12258
56	9941	10633	12255
57	9789	10536	12243
58	9621	10484	12224
59	9436	10394	12196
60	9235	10295	12160
61	9018	10185	12116
62	8784	10066	12064
63	8533	9737	11960
64	8266	9798	11890

and equipment as estimated by the institute:

Fees	$74.00
Application Fee	5.00
Books and Equipment	120.00
	$199.00

It was assumed that the cost to the individual for each year was $200.00. These costs, together with foregone earnings, constituted the total costs to the student.

Direct Costs to Society

Data for direct educational costs to society were provided by the Provincial Department of Education. They include the following:

(a) Teacher's Salaries
(b) Maintenance
(c) Supplies
(d) Administration
(e) Depreciation on buildings and equipment
(f) Books and equipment minus
(g) Fees

Although over a two-year period, the length of the technology programs, the components of social costs may rise at different rates, it is felt that no great distortion would arise by applying a 6% increase across the board rather than constructing price indexes for each component. In addition the data from the department were increased upward by 10% to

take account of imputed taxes on public buildings and also of the probability of understatement of depreciation in the provincial accounts.

The average social costs per student place for the year 1970-71 was $2637 which, when adjusted for imputed taxes and the increase in the price level for 1971-72, amounted to $3082. This figure represents the average social costs for the engineering programs at the two institutes. Ideally, marginal social costs would have been the relevant statistics. The derivation of marginal social costs was not possible since no analysis was undertaken on the internal efficiency of the institutes. If marginal social costs were much lower than average social costs, the estimated social rates of return would be lower than the actual. It is still a moot point what effects do cutbacks have on social costs; the discontinuation of a program over some time period may entail certain inevitable costs.

Sensitivity Analysis

Sensitivity analysis is applied in some parts of the study, in order to take account of some of the important intervening variables or considerations.

Interest rates. The rate of interest is varied to see what effects it has on the returns to the programs. This is in deference to the debate on the 'right' rate of interest and, in the private case in particular, to the riskiness of educational investment in imperfect capital and labour markets.

Differential abilities. There is the problem posed by differential abilities, motivation and social circumstances of high school graduates and graduates of institutes of technology. Denison (1962), in his famous study, suggested that college graduates would have higher earning ability than secondary school graduates simply on the basis of their inborn characteristics rather than on their education and training. In other words, had they not continued, they would have been in the upper quartile of the high school graduate earnings profile. Thus only about two-thirds of their increased earnings can be attributed to their education. This is the so-called Denison coefficient, which is accommodated by an adjustment of .33. Given that technology programs may be less forbidding than a degree program in engineering and that technologists are interstitial between engineers and secondary school graduates an adjustment of .17 is also made to account for differential ability.

Summer employment. The availability of summer employment reduced the opportunity costs to the student and society. The effect of this variable is examined. It is assumed that students in the technologies were subject to the same rate of unemployment as the overall rate for the economy in 1971. Although persons in the age group 18-24 have a higher rate than the national rate of unemployment and that continuing post-secondary education students experience unemployment rates as high as 15%, a 6% unemployment rate is used for the months of summer employment. Continuing students

in the engineering technologies faced a seller's market in 1971. Communication with the Canada Manpower Centres at the two institutes of technology suggested that more than 96% of the students found summer employment in 1971, and for 1972 there are more job offers than there are students. However, it is assumed that they earn the same salaries as the average high school graduate, although this is likely to lead to a negative bias since, with one year of training, they would be more productive than the former.

Manpower retraining. Manpower retraining schemes have emerged as an integral part of the efforts by national governments to correct for the effects of skill obsolescence and unemployment among workers. In the U.S. there are a multiplicity of schemes on which the unemployed worker may draw in his attempt to improve his employment prospects. In Canada, manpower retraining consists at present, mainly of short-term courses, but there is provision for courses of up to one academic year in length and which may be of technician type. There is some discussion in political circles of longer upgrading programs. Also too, the flexibility of the present educational systems does allow individuals to change careers during their working life.

Thus there are two possibilities that must be examined. One is the case where the younger student in the educational technologies decides to write his education off after a number of years in response to the changes in the market for his training. The other is the case where the individual in

the middle of his prime working life enters on the program. Through an iterative procedure we shall estimate the age at which the educational investment can be written off for a student aged 18; this is reported in terms of pay-back periods. Secondly, given relevant interest rates, we shall calculate the highest age at which it is still feasible financially to embark on a program of studies.

CHAPTER V

ANALYSIS AND DISCUSSION OF RATES OF RETURN

This chapter reports the results of the analysis of the private and social rates of return to programs in the engineering technologies. In the first section the private rates of return to technologists and technicians are examined and discussed. In the second section, the same treatment is given to social rates and in the final section, the differences between them are analysed and discussed together with the implications for educational planning.

PRIVATE RETURNS

Technologists

With the use of the formulae outlined in the previous chapter, the private internal rates of return, present values of discounted earnings streams and the cost-benefit ratios were calculated. Six different adjustments were made, with respect to technologists, to test for the sensitivity of the estimates to changes in variables that have been considered important. The adjustments represent assumptions about the 'state of the world' faced by students. Adjustments were made for:

I unemployment, mortality and personal income taxes

II unemployment, mortality, taxes and the probability of summer employment.

III unemployment, mortality, taxes, and the fact that the student may be 17% more capable than the average high school graduate.

IV unemployment, mortality, taxes and the fact that the student may be 33% more capable than the average high school graduate.

V summer employment included with adjustment III

VI summer employment included with adjustment IV

Table V shows the benefit-cost ratios at selected rates of interest and the internal rates of return under the varying assumptions. At a rate of interest of 5%, two year programs in the engineering technologies paid under all assumptions. For the most restrictive assumption, i.e. adjustment IV, the benefits were more than twice the costs. At 7.75% also, the rate of interest on Canada Savings Bonds in June 1971, the benefits outweighed costs by one half in five cases. At a rate of interest of 20%, however, only under adjustment II did benefits exceed costs. At 10%, the approximate rate of interest chargeable on student loans administered by the province, the present value was only $942 under adjustment IV but was $4,686 under adjustment II. With loans in the vicinity of $1,000 per annum per student, there is some likelihood that the investment was not profitable for some students.

The internal rates of return, defined as the rates of interest at which benefits are just equal to costs, are shown at the bottom of the table. The two-year programs

TABLE V

PRIVATE BENEFIT-COST RATIOS AND INTERNAL RATES OF RETURN FOR TECHNOLOGISTS

Rate of Interest %	Private Benefit-Cost Ratios					
	I	II	III	IV	V	VI
5.00	3.01	3.46	2.50	2.02	2.87	2.32
6.00	2.64	3.03	2.19	1.77	2.52	2.03
7.00	2.35	2.70	1.95	1.57	2.24	1.81
7.75	2.17	2.49	1.80	1.45	2.07	1.67
8.00	2.11	2.43	1.75	1.42	2.02	1.63
9.00	1.92	2.21	1.59	1.29	1.83	1.48
10.00	1.76	2.03	1.46	1.18	1.68	1.36
11.00	1.62	1.87	1.35	1.09	1.55	1.25
12.00	1.51	1.74	1.25	1.01	1.44	1.16
13.00	1.41	1.62	1.17	0.94	1.35	1.09
15.00	1.24	1.44	1.03	0.83	1.19	0.96
20.00	0.96	1.11	0.79	0.64	0.92	0.74
Internal Rate of Return %	19.09	22.30	15.54	12.16	18.25	14.34

yielded a rate of return of between 12.16% and 22.30%, where the former figure relates to the most restrictive assumption and the latter to the most generous.

Table VI gives the present values of net benefits at different rates of interest. At 5%, the present values ranged between $5,700 and $12,000 under the varying assumptions. At 7.75%, the range was between $2,400 and $7,000. At 20% only under adjustment II was the present value positive. At the internal rates of return shown in Table V, the present values of the programs were zero.

Table VII gives the length of the 'pay-back' period for different rates of interest. The pay-back period is simply the length of time it would have taken for the sum of benefits to outweigh the sum of costs. The table shows how long it would have taken a student, aged 18, to recover the total private costs of a program in the engineering technologies, given that the benefits stream would have commenced at age 20, the age at which he would have graduated. The dashes represent the occasions when the present value of benefits failed to exceed costs by the retirement age of 65; the pay-back period exceeded normal working life of 45 years. The pay-back period at an interest rate of 5% ranged between 5 years and 9 years. At 7.75%, the range was between 5 and 11 years.

Table VIII shows the highest age at which an individual might have embarked profitably on one of the two-year programs. The basic assumption of the table is that

TABLE VI

PRIVATE PRESENT VALUES IN 1971 DOLLARS FOR TECHNOLOGISTS

Rate of Interest %	Private Present Values					
	I	II	III	IV	V	VI
5.00	11264	11988	8397	5698	9121	6423
6.00	9069	9787	6587	4251	7305	4969
7.00	7356	8067	5177	3127	5888	3838
7.75	6309	7014	4317	2442	5023	3148
8.00	5995	6700	4060	2238	4764	2943
9.00	4896	5594	3159	1524	3857	2222
10.00	3994	4686	2422	942	3113	1633
11.00	3244	3930	1810	460	2496	1146
12.00	2611	3290	1295	57	1974	736
13.00	2072	2745	858	-283	1531	389
15.00	1204	1866	158	-825	820	-164
20.00	-198	435	-959	-1675	-325	-1041

TABLE VII

PAY-BACK PERIODS FOR PRIVATE COSTS FOR TECHNOLOGISTS

Rate of Interest %	Pay-Back Period in Years					
	I	II	III	IV	V	VI
5.00	5	5	7	9	6	7
7.00	6	5	7	10	6	8
7.75	6	5	7	11	6	8
10.00	6	5	9	15	7	10
13.00	8	6	12	-	8	17
15.00	9	7	22	-	10	-
18.00	14	8	-	-	24	-
20.00	-	10	-	-	-	-

TABLE VIII

HIGHEST AGE FOR PROFITABLE ENTRY FOR TECHNOLOGISTS

Rate of Interest %	Highest Age					
	I	II	III	IV	V	VI
1.00	29	30	28	27	29	28
2.00	28	28	27	26	24	25
3.00	26	27	25	24	26	25
4.00	25	25	24	23	24	24
5.00	24	24	23	22	23	23
6.00	23	23	22	21	23	22
7.00	22	23	21	20	22	21
7.75	22	22	21	20	21	21
8.00	21	21	21	20	21	20

the experience factor rather than age was the determinant of the salary earned. There is evidence of employer resistance to rewarding technologists for their pre-graduation employment experience. Thus a high school graduate aged 25 who enrolled in a program and graduated at age 26-27, would have foregone the average earnings of high school graduates, aged 25 and 26, and would have commenced with his new status at the salary of a technologist, aged 20. His earnings stream, therefore, is the same as that of a 20 year old who would retire at age 57. It is assumed then, that the experience and training that he had as a high-school graduate would have no influence on his earnings as a technologist.

With these constraints, the highest age for profitable entry was calculated at different rates of interest and under the different assumptions. At an interest rate of 1% and with adjustment II an individual aged 30, could have enrolled in one of the programs and would have earned enough over the rest of his working life to compensate for the investment costs. However, although the age variable was not sensitive to the assumptions, it was very sensitive to the rate of interest. This is due to the shape of the profiles of technologists and high school graduates. At an interest rate of 7.75% the student had to be no older than age 22 to reap the benefits and repay the costs of investment in a program.

Technicians

Given the basic model as outlined above, monetary returns were calculated for 18 year olds in one-year programs, leading to certification at the technician level. In the case of technicians only three different adjustments were made for the sensitivity tests:

I unemployment, taxes and mortality were taken into account.

II the student employed adjustment I but was 17% more capable than the average secondary school graduate.

III the student employed adjustment II but was 33% more capable than the average secondary school graduate.

Table IX shows the benefit-cost ratios, internal rates of return and the present values, under the three assumptions. At a 5% rate of interest, the benefit-cost ratio was between 2.89 and 4.32 while the present values ranged between $4,500 and $7,900. At 7.75%, the ratios were between 2.37 and 3.54 while the present values were between approximately $3,200 and $5,900. At a rate of interest of 20%, the benefit-cost ratios were still positive, lying between 1.37 and 2.05 and with present values between $785 and $2000. The internal rates of return turned out to be substantial--between 31% and 50%.

The pay-back periods and highest age for profitable entry are shown in Table X. As expected, given such high internal rates of return, the pay-back period was very short.

TABLE IX

BENEFIT-COST RATIOS, INTERNAL RATES OF RETURN, AND PRESENT VALUES IN 1971 DOLLARS FOR TECHNICIANS

Rate of Interest	Benefit-Cost Ratios			Present Values		
%	I	III	III	I	II	III
5.00	4.32	3.59	2.89	7883	6139	4500
6.00	4.00	3.31	2.67	7036	5440	3937
7.00	3.72	3.08	2.49	6336	4862	3475
7.75	3.54	2.94	2.37	5884	4490	3177
8.00	3.48	2.89	2.33	5745	4375	3085
9.00	3.28	2.73	2.20	5238	3975	2752
10.00	3.11	2.88	2.08	4796	3594	2462
11.00	2.95	2.45	1.98	4406	3274	2208
12.00	2.81	2.34	1.89	4059	2989	1981
13.00	2.69	2.23	1.80	3748	2733	1778
15.00	2.47	2.05	1.65	3209	2292	1429
20.00	2.05	1.70	1.37	2208	1475	785
Internal Rate of Return %	49.63	40.02	30.79			

TABLE X

PAY-BACK PERIODS FOR PRIVATE COSTS AND HIGHEST AGE FOR PROFITABLE ENTRY FOR TECHNICIANS

Rate of Interest	Pay-Back Periods in Years			Rate of Interest	Highest Age		
%	I	II	III	%	I	II	III
5.00	3	4	4	1.00	21	21	20
7.00	3	4	4	2.00	20	20	20
7.75	3	4	5	3.00	20	20	19
10.00	3	4	5	4.00	20	19	19
13.00	4	4	5	5.00	19	19	19
15.00	4	4	5				
18.00	4	5	6				
20.00	4	5	6				

At the highest rate of interest used, 20%, the payback period was only 6 years. In fact the pay-back period did not seem to be very sensitive to the rates of interest or to the assumptions in the case of technicians. The highest age for profitable entry on a one-year program, calculated on the same basis as in the case of technologists showed a similar lack of sensitivity to the assumptions.

Comparative Private Benefits

The earnings streams of technologists and technicians are compared in Table XI. The difference in benefits can be regarded as the marginal benefits of the additional year of training. Basing opportunity costs for both groups on the earnings of high school graduates led to the following observations. Although the internal rates of return on the one-year programs were higher than on the two-year programs, there were rates of interest at which the present values on technologist-type programs were higher than those for technicians.

Comparing the benefits stream under assumption I, for both technologists and technicians, it can be seen that at interest rates below 8%, the net present value of benefits was larger for technologists. However, if one includes ability adjustments the advantage was reduced considerably. Adjustments III and IV for technologists are based respectively, on factors of .17 and .33 for presumed superior intellect of the latter over the high school graduates. Assumption II for technicians includes an adjustment of .17. A comparison of

TABLE XI

COMPARATIVE PRIVATE BENEFITS FOR TECHNOLOGISTS AND TECHNICIANS

Rate of Interest	Technologists Present Values in 1971 Dollars			Technicians Present Values in 1971 Dollars	
%	I	III	IV	I	II
5.00	11264	8397	5698	7883	6139
6.00	9069	6587	4251	7036	5440
7.00	7356	5177	3127	6336	4862
7.75	6309	4317	2442	5884	4490
8.00	5995	4060	2238	5745	4375
9.00	4896	3159	1524	5238	3957
10.00	3994	2422	942	4796	3594
11.00	3244	1810	460	4406	3274
12.00	2611	1295	57	4059	2989
13.00	2072	858	-283	3748	2733
15.00	1204	158	-825	3209	2292
18.00	265	-592	-1399	2561	1763
20.00	-198	-959	-1675	2208	1475
Internal Rates of Return %	19.09	15.54	12.16	49.63	40.02

IV for technologists and II for technicians suggests that under the specified conditions, at any interest rate, a technician would have received higher net returns on his investment vis a vis a technologist.

Figure 3, Figure 4 and Figure 5 summarise in graphical form the major findings on private returns. Figure 3 shows the present values, at different interest rates, for technologists vis a vis high school graduates, Figure 5 shows a similar comparison for technicians, while Figure shows the comparison between technologists and technicians. The internal rate of return is that rate at which the curve bisects a line horizontal to the present value axis i.e. where present value of the stream is equal to zero. The higher curve for technologists represents assumption II; it takes account of mortality, taxes, the probability of unemployment and of finding summer employment during the program. The lower curve is based on assumption IV for technologists and includes the adjustment for mortality, taxes, unemployment and the superior ability factor of .33.

The curves in Figure 4 are based on assumptions I and III for technicians with the higher curve based on adjustments for mortality, unemployment and taxes. The lower curve includes assumption I and an ability weighting of .33. In both cases the curves illustrate the highest and lowest returns that can be reasonably expected. The real world, hopefully, lies somewhere between. In Figure 5 the highest estimated values for both groups are compared. The curves intersect

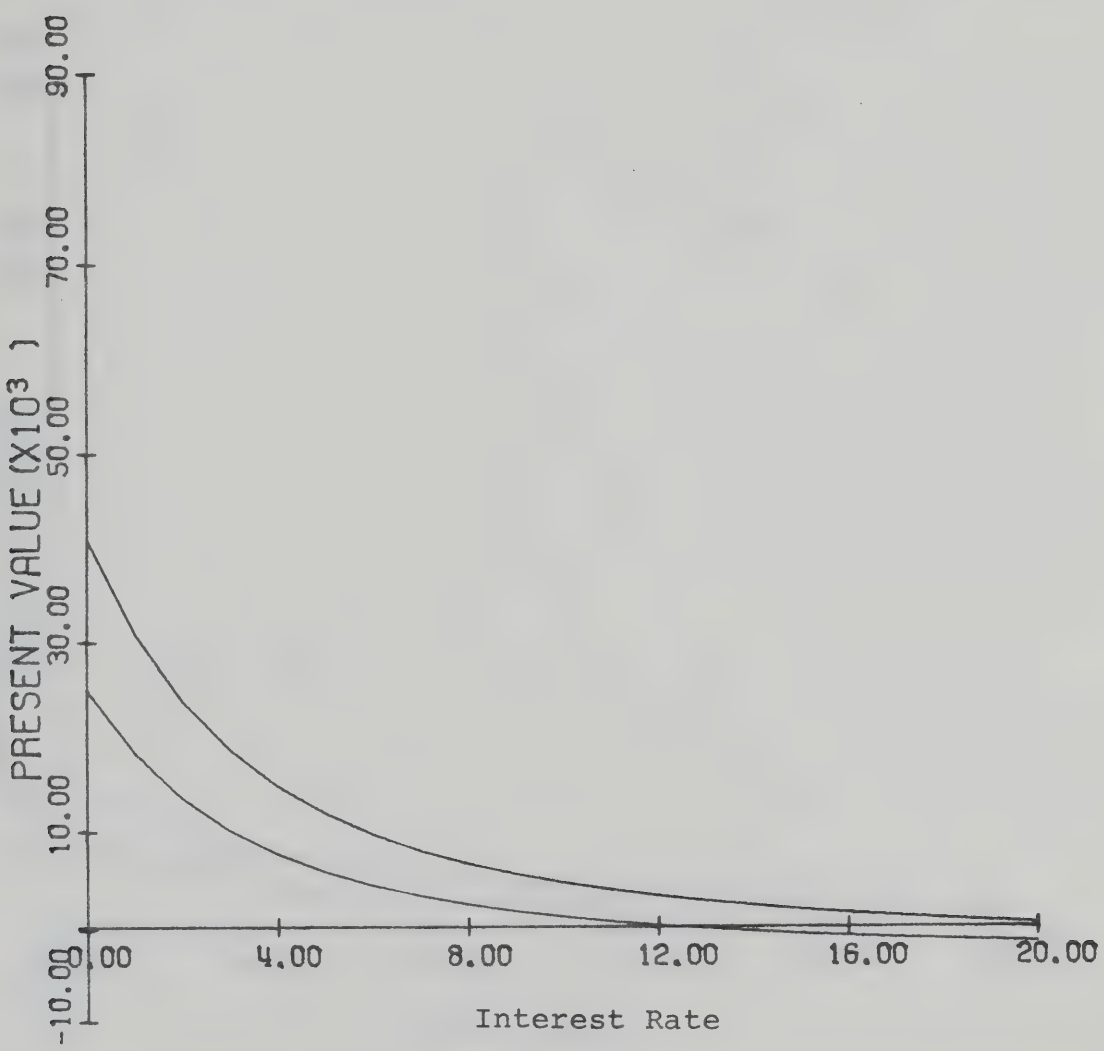

Figure 3: Highest and lowest private present values in 1971 dollars to technologists

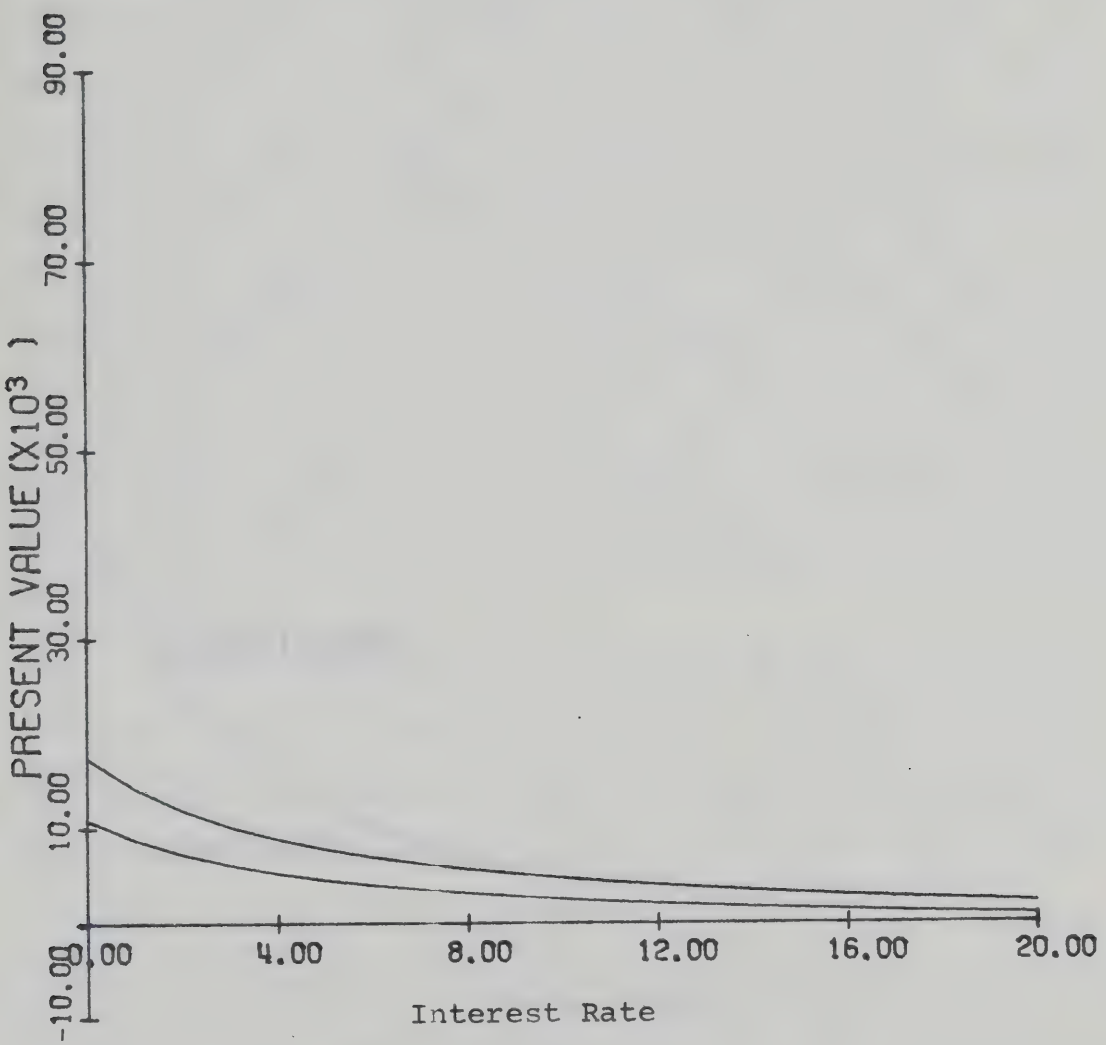

Figure 4: Highest and lowest private present values in 1971 dollars to technicians.

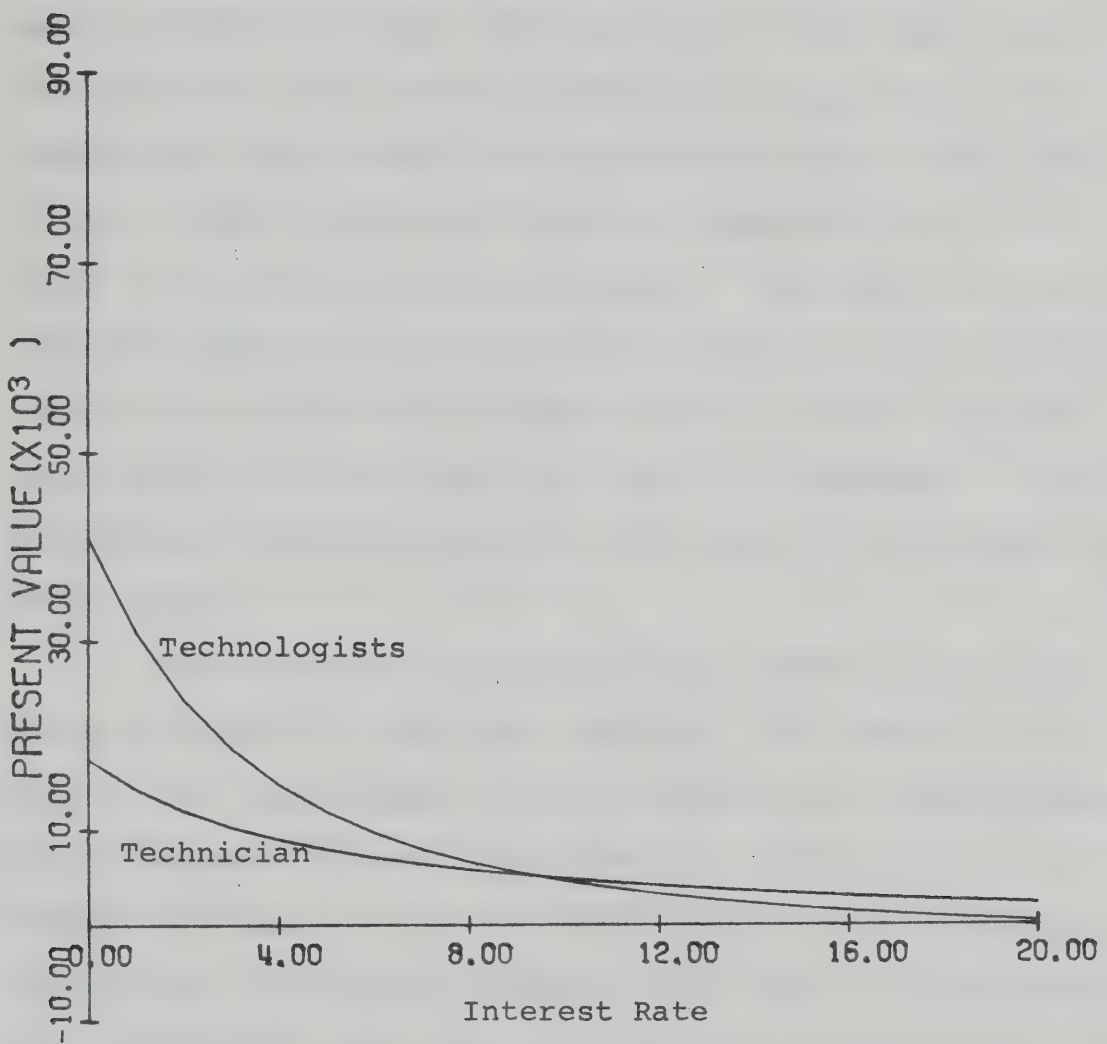

Figure 5: Comparison of highest private present values in 1971 dollars for technologists and technicians.

at an interest rate of between 8% and 9%.

Discussion of Private Rates of Return

The private rates of return to two-year programs leading to the Diploma in Engineering Technology seemed to yield substantial rates of return when the internal rate of return method was used. The rate was of the order of 12% when the most restrictive assumptions are applied; if the assumptions are relaxed the internal rate was of the order of 15% to 18% a rate which compares favourably with most types of non-educational investments. Similarly, the one-year programs showed very high internal rates of return--between 31% and 50%--which would suggest that the latter programs yield higher returns than most types of investment. Similar conclusions would be reached on the basis of the benefit-cost ratio method.

However when the present value method is used the benefits seemed to have been moderate. For example, at a rate of 12%, the present value of benefits for technologists ranged between $57 and $3,290, and the benefit-cost ratio between 1.01 and 1.74. For technicians, on the other hand, the present values were between $1,980 and $4,060 approximately, when the benefit-cost ratio was between 1.89 and 2.81. If one used the benefit-cost ratio method or the internal rate of return method exclusively, the conclusion would be that the returns to technicians were substantially above the returns to technologists, which is not borne out when the present

values of the stream are compared over a range of interest rates.

This finding corroborates the thesis advanced by Stager (1968) Musgrave (1964) and Wilson (1970) that the internal rate of return can lead to biased conclusions. In fact the benefit-cost ratio and the internal rate of return method tend to favour small projects over large ones. A project costing $2,000 and yielding $4,000 has a lower benefit-cost ratio compared to one costing $50 and yielding $150. If students were interested in maximising present value of net benefits, then the two-year program was obviously superior at certain interest rates. At a criterion rate of 8%, the present value of the two-year program might have been as high as $7,000 while the one-year program would have yielded only about $5,800. Yet the internal rates of return for technician programs are substantially above the two-year programs.

The pay-back period for technologists and technicians illustrate the importance of the scale of the investment. In the case of technologists the pay-back period proved to be highly sensitive to the rate of interest while within a 'reasonable' range of interest rates the pay-back period was not so sensitive. The pay-back period for technicians on the one-year programs was not sensitive to the selected range of interest rates. If students tended to emphasize rapid pay-back as a criterion for choice of a career, shorter courses and programs might be unduly emphasized to the longer

run detriment to both society and the individual. On the other hand, rapid pay-back may be a better criterion in an uncertain world for skills subject to erratic obsolescence.

The results on the highest age for profitable entry by high school graduates may appear startling at first. In both instances, in spite of the moderate and even substantial internal rates of return the highest age for profitable entry turned out to be low. In fact for the technicians, the age was much lower at 1% rate of interest than in the case of technologists. When one examines the earnings stream for technologists, technicians and high school graduates (Table IV) and compares these with the present value of benefits for a graduate who spends his maximum working life as a technologist or technician, the reason becomes clearer. For example, a high school graduate aged 25 had to forego income of somewhat less than $12,500 in current dollars in order to become a technologist. The present value of earnings at 5% for a technologist, aged 20, who spent his entire working-life in his field of training was approximately $12,000 (Table IV). The longer the training is postponed, the less profitable it is. If, however, the individual experiences protracted unemployment, his opportunity costs fall and the program can be profitable.

Two mitigating factors should be noted here. The assumption that the graduate starts at the bottom of the scale, whatever his previous experience, is somewhat restrictive, in spite of employer resistance to the recognition

of pre-graduation work experience. Secondly, the earnings for secondary school graduates, which formed the basis for calculation of opportunity costs in the study, have an upward bias since the D.B.S. survey did not distinguish between those who completed secondary school and those who had had formal non-university post-secondary education. Thus the estimates derived here have to be applied with caution. The second caveat suggests that the actual rates of return and present values might have been somewhat higher.

The inclusion of summer earnings improves the rate of return by about 3% as seen in adjustments I and II for technologists--22.30% as against 19.09%. This finding emphasises the fact that opportunity costs are the major component of private educational costs and are relevant in considerations of equity among groups. Lower class students or students from disadvantaged groups may be unable to take advantage of the two-year programs unless they receive substantial student grants or soft loans. Remission of fees is miniscule relative to the opportunity costs. Summer employment reduces the private and social costs of education, by implication, improves returns on the educational investment.

In sum, when returns are assessed with the internal rate of return method, both programs show high profitability. However when the present value method is used the returns were moderate, with the one-year programs showing higher present values at higher interest rates i.e. above 10%. This suggests that demand and supply for technologists and technicians in

the province were reasonably matched and that any substantial increase in enrolment, unaccompanied by rapid economic growth, and thus in demand for these skills, would result in a fall in the returns on those educational programs. The objective of educational planning should be to maintain this balance and ensure that it is not achieved simply by accident.

SOCIAL RETURNS

The same methodology, given the assumptions outlined in Chapter IV, was applied in the derivation of estimates on social internal rates of return, social present values and social benefit-cost ratios. The basic assumption is that society seeks to maximise the monetary returns on educational programs. An important observation must be made at this pojnt. In the private case, costs to the student were regarded as given. However this assumption is weaker in the social case. The internal efficiency of the institutes of technology was not examined in the analysis. Social returns can be improved not only by an increase in the benefits but also by a reduction in the costs per student place. The latter can be achieved by a reduction in the costs of training the same number of students to the required level of competence, by increasing enrolment and maintaining standards with the same economic resources, or by better utilization of facilities in annual or daily time units. Thus implicit in the use of the social costs data is the assumption that the institutes were operating at the optimal level of resource use and that social costs

were equal to marginal social costs. This might not be true in fact.

Technologists

Tables XII and XIII present social benefit-cost ratios, internal rates of return and present values on the basis of the assumptions made, with respect to technologists, at the beginning of the present chapter. The internal rate of return ranged between 8.15% and 13.88% under the most restrictive and the most generous assumptions respectively. At 7.75%, the rate of interest on government bonds in 1971, the benefit-cost ratios were all above unity. Table XIII is more revealing. The social present values showed a high degree of sensitivity to changes in the rate of interest. Under assumption I, a 1% increase in the interest rate from 5% to 6%, reduced the present value of returns by almost $4,000, and under assumption II doubling of interest rate from 5% to 10% resulted in a reduction in the present value of almost 4/5--from $15,490 to $3,750. At 10%, the approximate rate of interest charged on student loans, the present values under assumptions V and VI were negative while under assumptions I and II they were $2,769 and $3,573.

The pay-back period on social costs for the two-year programs are presented in Table XIV. At 5%, the pay-back period ranged between 8 years and 18 years. The pay-back period was sensitive both to the rate of interest and to the assumptions.

TABLE XII

SOCIAL BENEFIT-COST RATIOS FOR TECHNOLOGISTS

Rate of Interest %	Benefit-Cost Ratios					
	I	II	III	IV	V	VI
5.00	2.22	2.39	1.84	1.49	1.98	1.60
6.00	1.92	2.07	1.60	1.29	1.72	1.39
7.00	1.70	1.83	1.41	1.14	1.52	1.23
7.75	1.56	1.67	1.29	1.04	1.39	1.12
8.00	1.51	1.63	1.26	1.02	1.36	1.09
9.00	1.37	1.47	1.14	0.92	1.22	0.99
10.00	1.25	1.34	1.04	0.84	1.12	0.90
11.00	1.15	1.23	0.95	0.77	1.02	0.83
12.00	1.06	1.14	0.88	0.71	0.95	0.76
Internal Rate of Return %	12.78	13.88	10.39	8.15	11.30	8.87

TABLE XIII

SOCIAL PRESENT VALUES IN 1971 DOLLARS ON PROGRAMS FOR TECHNOLOGISTS

Rate of Interest %	Social Present Values					
	I	II	III	IV	V	VI
5.00	14645	15488	10115	5852	10958	6695
6.00	10981	11816	7103	3452	7932	4287
7.00	8160	8987	4788	1615	5615	2442
7.75	6454	7275	3393	512	4215	1334
8.00	5948	6768	2980	186	3800	1006
9.00	4190	5002	1547	-940	2359	-129
10.00	2769	3573	393	-1843	1198	-1038
11.00	1606	2403	-547	-2574	250	-1777
12.00	641	1431	-1323	-3172	-533	-2382

TABLE XIV

PAY-BACK PERIODS FOR SOCIAL COSTS ON PROGRAMS FOR TECHNOLOGISTS

Rate of Interest %	Pay-back Periods in Years					
	I	II	III	IV	V	VI
5.00	9	8	12	18	10	15
6.00	9	8	13	22	11	18
7.00	10	9	15	29	13	23
7.75	11	9	17	38	14	28
8.00	11	10	18	42	14	31
9.00	12	10	23	-	17	-
10.00	14	12	35	-	22	-
11.00	17	13	-	-	36	-
12.00	24	16	-	-	-	-
13.00	-	22	-	-	-	-

Technicians

Table XV presents the estimated social benefit-cost ratios, internal rates of return and present values for one-year programs in the engineering technologies. The internal rates of return were again substantial ranging between 28.29% and 15.88%. At an interest rate of 20%, the present values under assumptions I and II were positive. The benefit-cost ratio at 7.75% ranged between 1.5 and 2.2, while the present value was between $2683 and $6627. At 5% the present values were all substantial--between $4,713 and $9,726. Doubling the interest rate from 5% to 10% reduced the benefit-cost ratio by 0.8 and the present value was reduced to about half the present value at 5%--from $9,726 to $5,000.

Table XVI shows the pay-back period on social costs. At 7.75% the period ranged between 5 and 8 years and at 15% between 6 and 15 years. At low rates of interest the pay-back was not particularly sensitive to interest rate changes. Under assumptions I and II doubling of the interest rate from 5% to 10% did not extend the period and under assumption II it increased by only 2 years. However, under assumption III an increase in the ratio from 10% to 20% extended the period from 9 years to a period beyond 46 years of working life of a technician aged 19.

Comparative Social Benefits

A comparison of the social internal rates of return for technologists and technicians suggests that the returns on technician-type programs outstripped by far the returns to

TABLE XV

SOCIAL BENEFIT-COST RATIOS AND PRESENT VALUES FOR TECHNICIANS

Rate of Interest %	Benefit-Cost Ratios			Present Value in 1971 Dollars		
	I	II	III	I	II	III
5.00	2.8	2.3	1.9	9726	7143	4713
6.00	2.6	2.1	1.7	8396	6049	3840
7.00	2.4	2.0	1.6	7315	5160	3132
7.75	2.2	1.9	1.5	6627	4595	2683
8.00	2.2	1.8	1.5	6417	4423	2546
9.00	2.1	1.7	1.4	5656	3800	2053
10.00	2.0	1.6	1.3	5002	3265	1630
11.00	1.9	1.5	1.2	4432	2800	1264
12.00	1.8	1.5	1.8	3931	2392	943
13.00	1.7	1.4	1.1	3485	2029	659
15.00	1.5	1.3	1.0	2725	1414	180
20.00	1.3	1.1	0.9	1352	309	-672
Internal Rate of Return %	28.29	21.90	15.88			

TABLE XVI

PAY-BACK PERIODS FOR SOCIAL COSTS FOR TECHNICIANS

AT SELECTED RATES OF INTEREST

Rate of Interest	Pay-Back Period in Years		
%	I	II	III
5.00	5	6	7
6.00	5	6	7
7.00	5	6	8
7.75	5	6	8
8.00	5	6	8
10.00	5	6	9
13.00	6	7	11
15.00	6	8	15
18.00	6	9	-
20.00	7	11	-

technologists. The internal rate for the latter ranged between 8.87% and 13.88%, while for the former it ranged between 15.88% and 28.29%. Comparison of present values yields the same type of relationship as was found in the private case as can be seen in Tables XIII and XV. At the lower interest rates the two-year programs had an important advantage. At 5%, the highest probable present value for technicians was about $9,726 while for technologists it was about $15,000, almost $6,000 more. If, as is sometimes argued, society has a lower rate of discount than the individual, then the two-year program is superior at lower rates of interest in terms of its maximisation of present values. However at higher rates of interest, the one-year programs had the advantage. These facts are illustrated in Figure 6. The curves which represent the highest for each group, intersect at an interest rate of between 8% and 9%.

Discussion of Social Rates of Return

The differing results that can be derived from the present value method of evaluation and the benefit-cost ratio or internal rate of return imply that educational planners face no simple task in attempting to improve the external efficiency of the educational system--the efficiency with which it contributes to the total goals of the social system. The present study is narrow in scope and examines this efficiency solely in monetary terms.

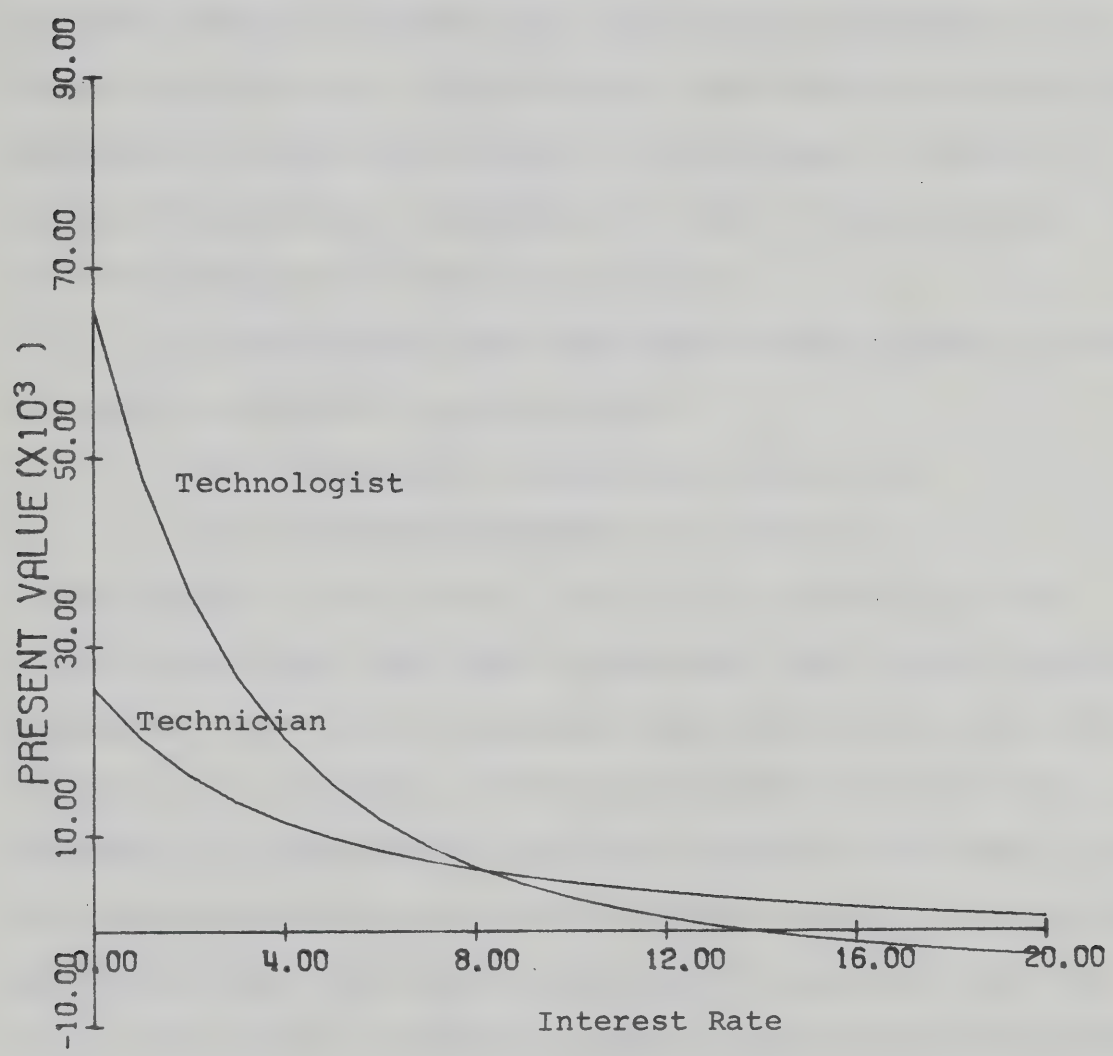

Figure 6: Comparison of highest social present values in 1971 dollars for technologists and technicians.

Fortunately in some cases the ambiguity is resolved for the administrator. If the government as guardian of society's interest imposes some criterion rate of interest for public investment, the educational administrator would consider the programs that yield maximum present values at the criterion rate of interest. In the present case, two-year programs would be chosen over the one-year programs at low criterion rates i.e. less than 8%, and the priority would be reversed at much higher rates. The problem is seldom so neat and thus value judgments will play a more important role in determining the choice of programs.

In considering the findings on social rates of return, two factors must be borne in mind:

(a) differential bargaining power, and

(b) alternative methods of training

With respect to the former, there is a possibility that technicians might have had an advantage over technologists in bargaining power with employers since the latter were less likely to be unionised. The earnings data on which the estimates of contribution to social product were based, might not be representative of the real contribution of technologists. Employers might have paid technologists somewhat less than their true worth. Although society still reaped the benefits of the total output of the group, some proportion of the higher private profits of employers would have included the contribution due to technologists. If the before tax-earnings of the latter under-represented their social contribution, the

internal rates of return and the present values were biased downward. These are the effects of the monopsonistic power of employers and the absence of unionisation among technologists.

It was assumed that the main method of training of technicians and technologists was through one and two-year programs at the Institute of Technology. In the cases of technicians, and to a lesser extent of technologists, on-the-job training has been more important in the past. ASET makes certification conditional on the achievement of certain academic requirements which may be accomplished through night-school and/or correspondence courses. The implication of all this is that the present estimates of social costs may be biased downward if on-the-job training was as effective but less costly on average than formal training at an institute of technology.

Given the earnings stream of returns on the one-year programs, and given the limited pay-back periods, the one-year program was a superior choice for retraining schemes to the two-year programs. Furthermore the shorter pay-back period provided a hedge for society against the risk of losses in occupations which are subject to rapid obsolescence.

In sum, if the higher rates of interest that were in force in 1971, are used for discounting returns, the one-year programs were more profitable in terms of present values and benefit-cost ratios.

PRIVATE AND SOCIAL BENEFITS AND EDUCATIONAL PLANNING

One of the most crucial functions of educational administrators and planners is in the reconciling of private and social goals in education. The two may diverge for a number of reasons. In the present context these may be classified as economic and non-economic. The role of the administrator in the presence of this antinomy is to strike a reasonable balance between the needs of individuals and the needs of society. In effect, the administrator has to employ a 'satisficing' rather than a 'maximising' approach.

A comparison of the highest private and socail present values for a selected range of interest rates for both technologists and technicians illustrates the divergence in private and social returns. At an interest rate of 5%, the present value on the two-year programs was $11,988 and $15,488 in the private and social cases respectively. At 8%, the value was $6,700 and $6,768 and at 12% it was $3,290 and $1431 (Tables VI and XIII). Similarly in the case of the technicians, private present value was $7,883 at 5%, $5,745 at 8% and $4,059 at 12%, while social present value was $9,726, $6,417 and $3,931 at the same rates respectively (Tables IX and XV). At lower rates of interest therefore, social benefits exceeded private benefits. At an interest rate between 8% and 9%, the situation changed with private present values exceeding social present values. A similar result was noted for technicians at an interest rate between 11%, and 12%. Social benefits were more sensitive to interest

rate changes. Figure 7 and Figure 8 show the points of intersection of the private and social present value curves for technologists and technicians respectively.

The implication of these results, applied to a broader framework of educational investment, is that when, at high interest rates, the social benefits exceed the private benefits, there is a rationale for governments to consider subsidising individuals who would not otherwise enrol in the relevant programs. On the other hand when private rates are far in excess of social rates, increases in fees and reduction in relative enrolment are some of the instruments that can be used to achieve an adequate balance. The granting of subsidies and increases in fees change the shape of both curves because of their impact on costs.

The conflict between private and social objectives does not relate solely to the intersection of private and social present values. If, as Sen (1967) and Marglin (1963) argue, a lower rate of discount should be used for social projects than in the case of private investment, then the social present values may be very high at a low rate of discount relative to the private present value. Reference to the figures illustrates this. The conflict is not easily resolved in such a case. Not all are agreed, however, on the use of a lower rate of discount (Baumol, 1970).

The result tends to confirm the alleged weakness of planning models that rely on the social demand approach, or the manpower requirements approach. With respect to the

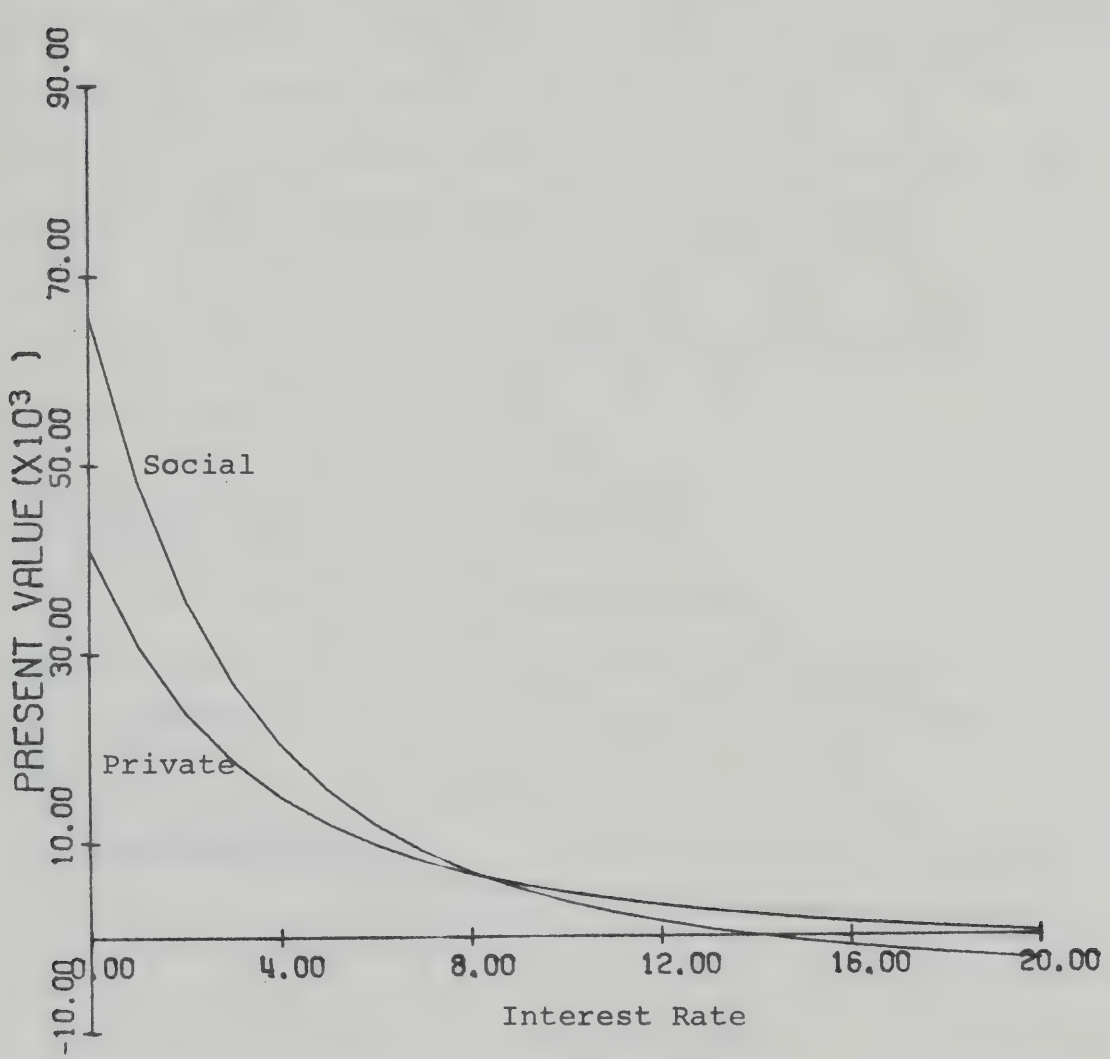

Figure 7: Comparison of highest estimated social and private present values in 1971 dollars for technologists.

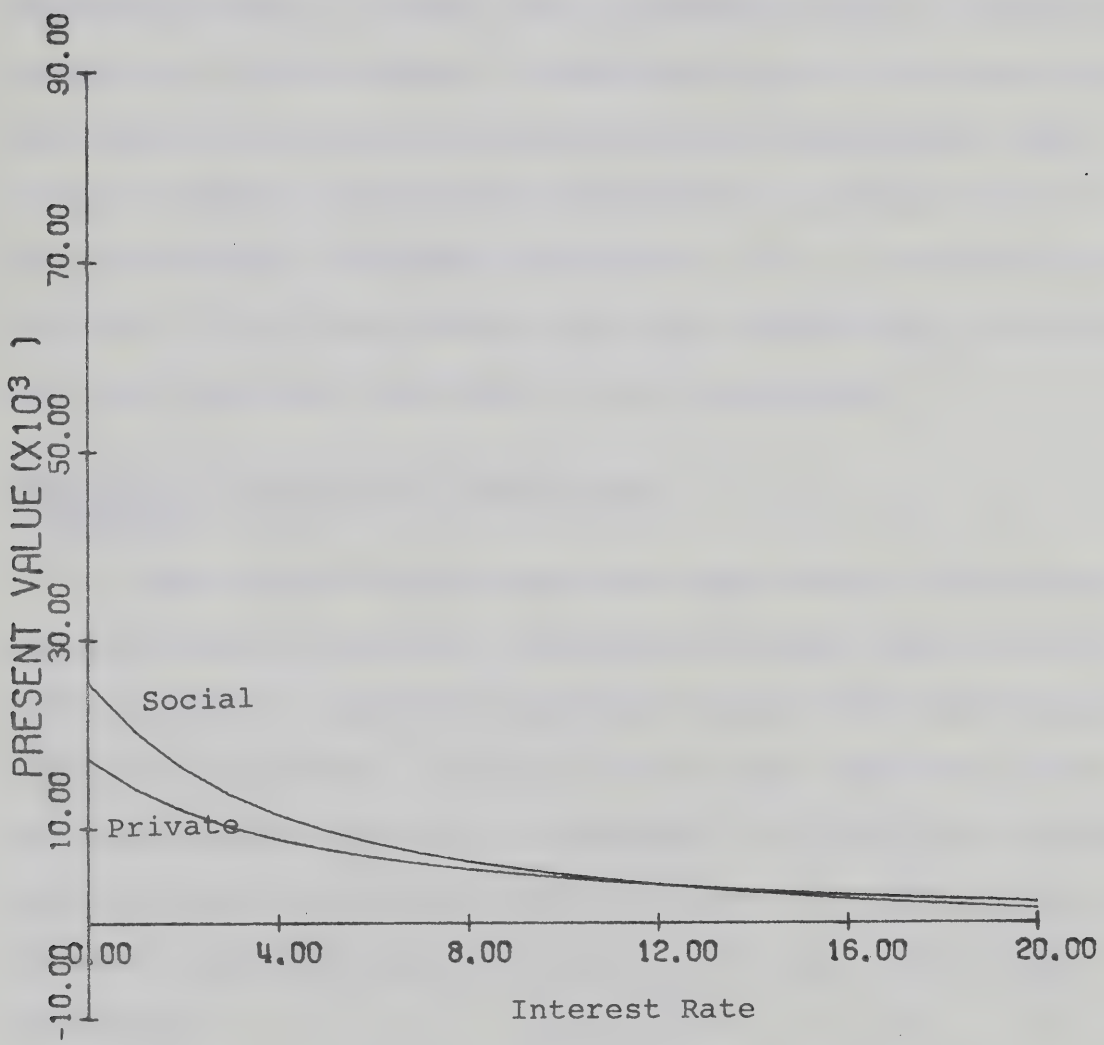

Figure 8: Comparison of highest estimated social and private present values in 1971 dollars for technicians.

former approach, involving a passive response to enrolments or straight-forward extrapolation of student demand, private benefits would have primacy over social benefits which, as the figures show, can be negative even though private benefits are positive. On the other hand, the manpower requirements approach merely changes the order, with social benefits presumably having primacy over private benefits. The problem is that in a free society, individuals would not invest time and money in educational programs unless they expect some private reward. If private benefits in a program are far below the social benefits, society may fail to maximise total returns, if too few students enrol in the program. The rate of return approach can show up the divergences.

Relevance to Continuing Educational Planning

The rate of return approach need not be limited to the derivation of private and social present values and the like but can be a powerful tool for educational planning as a continuous process. The use of the wage function allows for the periodic updating of findings. In fact the calculated rates of return at any point in time are not endowed with any inherent constancy but are liable to fluctuate and change drastically.

The wage function illustrates how total undiscounted earnings are matched with age and experience within an educational or occupational category. The premise is that, all other things being equal, the more experienced a

technologist is, the higher would be his income relative to that of a similarly trained technologist with less experience. If average starting salaries for this occupational category rises by more than the average for the economy, then, it can be argued, the demand for this skill is showing some buoyancy. Employers cannot raise starting salaries for new entrants without according commensurate increases to experienced and similarly trained workers within the firm. These factors tend to maintain the relationship between experience and earnings within an occupational category, even if there are long lags in the adjustment process.

If, for illustrative purposes, average starting salaries of technologists rise by 5% from 1971 to 1972, and the earnings of secondary school graduates rise by only 3%, it is a fair assumption that the age-earnings profiles for both groups would rise by the respective amounts even if after a lag. Given that the shapes of the profiles for 1971 are already derived, it is possible to calculate both private and social rates of return on the basis of the adjusted profiles for 1972. It is possible that although the rate of return to technologists increased, there are other groups, occupational or educational, which show even higher rates of return. Comparison of costs and benefits among different types of programs would allow the educational planner to determine which areas of the educational system need to be expanded or contracted, which students are in greater need of subsidies given the distribution of private and social

benefits. This final decision can have a non-economic input in the light of the other important private and social goals. This information has implications not only for policy-making, but for student counselling and private decision-making.

The procedure outlined above obviates the necessity for large scale annual surveys for planning purposes. However, the shape of the profiles may change over time. Pension schemes and other institutional factors render the older workers less mobile; they are locked in the employing establishment and this allows employers more bargaining power with them than with the new entrants. Thus average starting salaries may rise without general increases for others involved in the occupation. Thus the functions may be less useful in long-term planning. For short-term and even medium-term planning, (5 years for example) it is a simple and perhaps the safest method for reconciling private and social goals, given the present state of knowledge.

Comparison With Other Studies

The research on returns to non-university post-secondary education in Canada and in Alberta is exceedingly limited. This may be due to the lack of data on graduates of community colleges and institutes of technology or to the belief that this form of education is somehow peripheral to post-secondary education activities. Stager (1968) computed private and social internal rates of return, benefit-cost ratios and present values for most types of post-secondary education in Ontario. However his estimates were based on

1961 census data and thus it is hazardous to update his present value estimates for comparison with the present study's. Thus only his benefit-cost ratios and internal rates of return can be used. On the basis of the assumption that the differential in earnings of graduates of institutes of technology and high school graduates is all due to education (the equivalent of assumption I for technologists and technicians in the present study) he arrived at the benefit-cost ratios and internal rates of return shown in Table XVII. He also used an alternative assumption the equivalent of assumption IV for technologists and III for technicians. His estimates include technicians with technologists. The estimates for technologists in the present study approximate those of Stager. But the internal rates for technicians are inordinately high compared to Stager's. The private and social benefit-cost ratios at 5% for technologists in Alberta conform very closely to Stager's estimates for Ontario. There is a much greater divergence on private and social internal rates of return in the Albertan case than there was in Ontario.

Wilson (1970) examined the private rates of return to Albertan engineers in 1968. This study is important for comparative purposes since some technologists do continue on to university engineering programs. Wilson did not make adjustments for mortality, taxes, and unemployment. He found that the internal rate of return to males, aged 18, was 21.12% on four-year engineering degree programs which is slightly below a comparable estimate for technologists of 22.30%.

TABLE XVII

COMPARISON BETWEEN

ONTARIO 1965 AND ALBERTA 1971

		Benefit-Cost Ratio at 5%		Internal Rate of Return %	
		Private	Social	Private	Social
ONTARIO 1965	Assumption I	3.0	2.3	12.9	10.6
	Assumption II	2.0	1.5	9.4	7.6
ALBERTA 1971					
Technologists	Assumption I	3.0	2.2	19.1	12.8
	Assumption II	2.0	1.8	12.2	8.2
Technicians	Assumption I	4.3	2.8	50.0	28.3
	Assumption II	2.9	1.9	31.0	15.9

However the present value of the four-year programs at an interest rate of 6% was $37,757 in 1968 dollars, whereas in the present case it was just under $10,000 in 1971 dollars. This is another instance of the importance of examining the present values along with the internal rate of return.

CHAPTER VI

SUMMARY, CONCLUSIONS AND IMPLICATIONS

PURPOSE OF THE STUDY

The major objective of the study was to evaluate and compare the private and social monetary returns to non-university programs in the engineering technologies offered at the Albertan Institutes of Technology. The two types of program examined were:

(a) two-year programs leading to the Diploma in Engineering Technology, and

(b) one-year programs leading to the certificate in Engineering Technology.

In the light of the evaluation, an attempt was made to relate the divergence in private and social returns to the function of educational planning.

METHODOLOGY

The research procedures employed in the study are derived from the human capital model in which educational investment is treated as any other type of investment. Thus the major analytical criteria used were the internal rate of return, benefit-cost ratios and present values of the investment. A wage function was used to estimate earnings for each age-cohort at the three educational levels considered.

The earnings data for technologists and technicians were based on the results of a mail questionnaire survey conducted by the Alberta Society of Engineering Technologists in 1971. The earnings data for high school graduates consisted of updated estimates of average earnings of high school graduates in a 1967 D.B.S. survey. The latter earnings provided the opportunity cost estimates for additional years of education and training. Private direct costs were based on the estimates as published by the Institutes while direct social costs were provided by the Provincial Department of Education.

In the derivation of the returns, sensitivity analysis was applied by introducing adjustments and modifying assumptions and examining what effect these changes had on the benefits. Thus a range of estimates is provided and the choice of one estimate over another has to be based on the tenability of the assumptions and one's view of the world.

The Limitations

The major limitation of the study is the nature and size of the sample of technologists and technicians. The Alberta Society of Engineering Technologists is only a semi-professional organization and membership of it is not a legal requirement for practice as a technologist or technician in the province. Thus the sample might have been biased.

The wage function used is simplistic in formualtion since no attempt was made to examine for the other variables that influence the earnings such as size of firm, urban-rural differences, post-graduation training and ability within the

educational/occupational category.

There was no examination made of the internal operation of the institutes of technology. If social costs can be reduced by greater efficiency, the estimated rates of return are likely to be lower than they were. Furthermore marginal social costs and average social costs may not be equal. Finally non-economic goals are purposely omitted in the analysis. They may be, however, more important both to the individual and to society.

FINDINGS

It was found that the private internal rates of return for one-year and two-year programs were high, relative to 'normal' interest rates. The two-year programs were yielding internal rates between 12% and 22%, and the one-year programs between 30% and 50%. However when the present value method was used the capital sums turned out to be moderate. At the 10% interest rate on student loans, private present values ranged between $942 and $4686 for technologists, and between $2462 and $4796 for technicians. When account is taken of the risks of obsolescence in these occupations the returns were not excessive. This suggested that demand and supply for technologists and technicians were reasonalby matched.

A similar analysis of social rates of return showed that at low rates of interest, the present value of benefits was quite large; this was not the case at slightly higher interest rates and the social present values were very

sensitive to the rate of interest. The social internal rates of return for technologists were again lower than those for technicians ranging between 8.15% and 13.88% for the former and between 15.88% and 28.29% for the latter. At lower internal rates the social present value was somewhat higher for technologists than for technicians. For example at an interest rate of 5%, the social present values were between $5852 and $15,488 for technologists and $4713 and $9726 for technicians. At higher interest rates the advantage of the two-year program was eliminated and reversed. On the whole, the returns to this type of human capital are comparable to the returns to physical capital. For one-year programs may appear high but when the risks of obsolescence are taken into account the rates can be considered moderate.

Comparison of the private and social rates of return confirmed the possibility of divergence between the two in both the case of technologists and of technicians. For both groups, social present values exceeded the private at lower interest rates but above 9%, in the case of technolgoists, and above 12%, in the case of technicians, the private benefits exceeded social benefits. The implications of this finding is that the social present value can become negative with private present value continuing to be positive when the same rate of discount is used.

While the pay-back periods on the programs were short for students entering on the programs at age 18, the post-ponement of entry to a much later age resulted in negative

present values because of the higher opportunity costs component. However the programs, especially the one-year programs, would be feasible for individuals who, unemployed for protracted periods, had low or minimal opportunity costs.

CONCLUSIONS

The study was oriented particularly to the needs of educational planning. By deriving a wage function and the current costs and benefits of the programs it was possible to show how the rate of return approach can be integrated with short and medium-term planning in education. Thus besides reporting the returns of these programs, which results are of some importance per se, the study explores a wider problem.

In the light of the findings, it does not seem that any but a moderate increase in enrolments is called for at the present stage. Demand and supply of technologists and technicians seem reasonably matched at the moment. Of course, if substantial expansion was undertaken, the graduates would find employment but only at lower salary scales as they find themselves forced to compete with high-school graduates. The social costs and benefits of this form of upgrading of the labour force were not examined here. Finally, in terms of capital sums, both programs pay moderate benefits.

IMPLICATIONS FOR FURTHER RESEARCH

Further research is necessary in other areas of the non-university post-secondary system. The present study examined only one area of it. There is a need for comparative information on the returns to the other programs since students would be making comparisons across fields of specialization in choosing career-goals. Only with such global information can planners and administrators exercise rationality in deciding on expansion or contraction of programs.

There is a need for some intensive research on the effectiveness of the graduates as assessed by employers. Although the institutes do have employers represented on their boards of management, it is still possible for the training supplied by the institutes to diverge considerably from the needs of employers. Furthermore research can be undertaken to assess the efficiency of on-the-job training vis a vis formal training at the institutes.

The increasing importance of training schemes suggests the need for an examination of the returns to individuals who have taken the longer programs offered by the institutes and for a comparison between their earnings and efficiency vis a vis individuals who had had these programs in their late teens or early twenties.

There is a need for much more research on wage functions. Some examination can be made of the importance of

the various income determining factors, and their differential impact among professions. Another aspect of the same problem relates to the stability of the wage function. The reliability of starting salaries as a criterion for the level of the wage function needs to be tested, as well as the hypothesis that older employees tend to get 'locked in' and have limited bargaining power compared to new entrants. Fluctuations in the business cycle would have some impact on the wage function.

Finally the direct social costs are in need of some research. These are almost as large as the opportunity costs to the students. The rationalization of social expenditure, with a constant level of efficiency, would improve the social rates of return. The internal efficiency of the institutes must be examined together with their external efficiency. Only the latter was analysed here.

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APPENDIX A

Questionnaire for 1971 Annual Survey of the Alberta Society of Engineering Technologists

Please complete this form, fold, staple, and return it to reach this office on or before JULY 31, 1971.

In completing the questionnaire, please do not sign your name or otherwise disclose your identity.

Your support is encouraged because the results of the survey will only be meaningful if a large percentage of the membership replies.

1. AGE: _____ years.

   Diploma in Engineering Technology: 19____.

   Year of Certification: 19____.

   Technical experience: _____ years.

2. What is your level of certification with the Alberta Society of Engineering Technologists?

   ___ TECHNICIAN IN TRAINING

   ___ TECHNICIAN

   ___ SENIOR TECHNICIAN

   ___ TECHNOLOGIST

   ___ SENIOR TECHNOLOGIST

3. In what field of Technology are you certified?

___ Aeronautical	___ Gas
___ Agricultural	___ Geology
___ Architectural	___ Geophysical
___ Chemical	___ Ind. Production
___ Civil	___ Instrumentation

___ Communications	___ Materials
___ Construction	___ Mechanical
___ Corrosion	___ Metallurgical
___ Drafting	___ Petroleum
___ Electrical	___ Power Plant
___ Electronic	___ Survey

4. What is your MONTHLY before tax rate of remuneration for technical services as of July, 1971

EXCLUDING

- bonus payments based on the performance of the organization you work for,
- employer's contributions to pensions, insurances and other employee benefits, but

INCLUDING

- bonus payments and commissions that compromise part of your NORMAL earning?

RATE OF REMUNERATION $_____ per month (on July 1, 1971).

COMMENTS

APPENDIX B

Sixth Annual Salary Survey of Ontario Association Certified Engineering Technicians and Technologists

SIXTH ANNUAL SALARY SURVEY

ONTARIO ASSOCIATION OF CERTIFIED ENGINEERING TECHNICIANS AND TECHNOLOGISTS

As in 1970, the survey was anonymous and the reporting date was July 1st.

AVERAGE INCREASE

A comparison of the median salaries paid to all members in 1970 and 1971 indicates an increase of 7.7%.

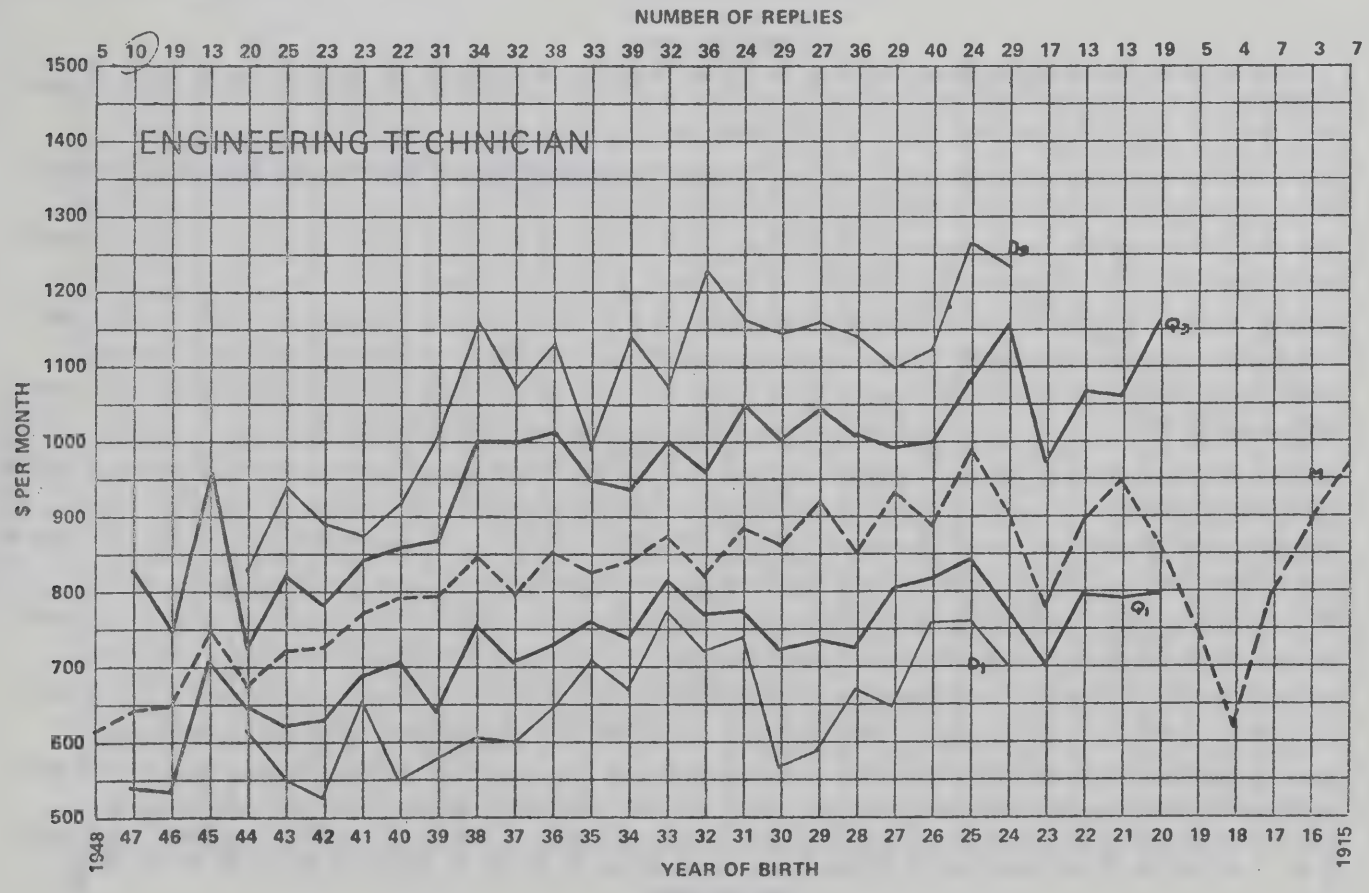
RESPONSE

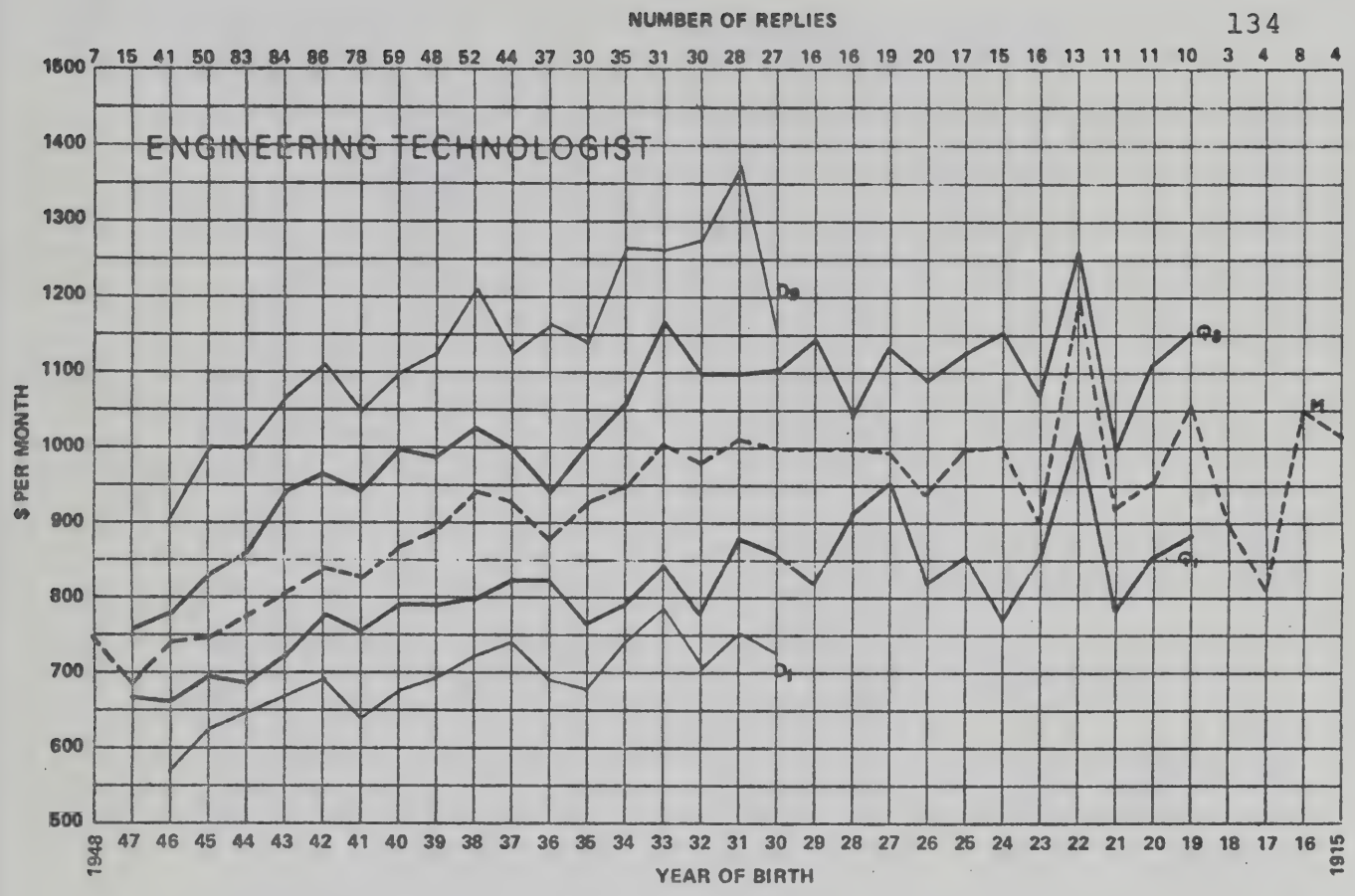
The number of returns was the highest ever and the response rate was 46.8%. Unfortunately, for a variety of reasons, 252 returns were not or could not be used. The survey therefore is based on a total of 2,646 returns: Technologists 1,048; Senior Technicians 837; Technicians 761. No graph has been drawn for all members as one group or another tends to distort the picture.

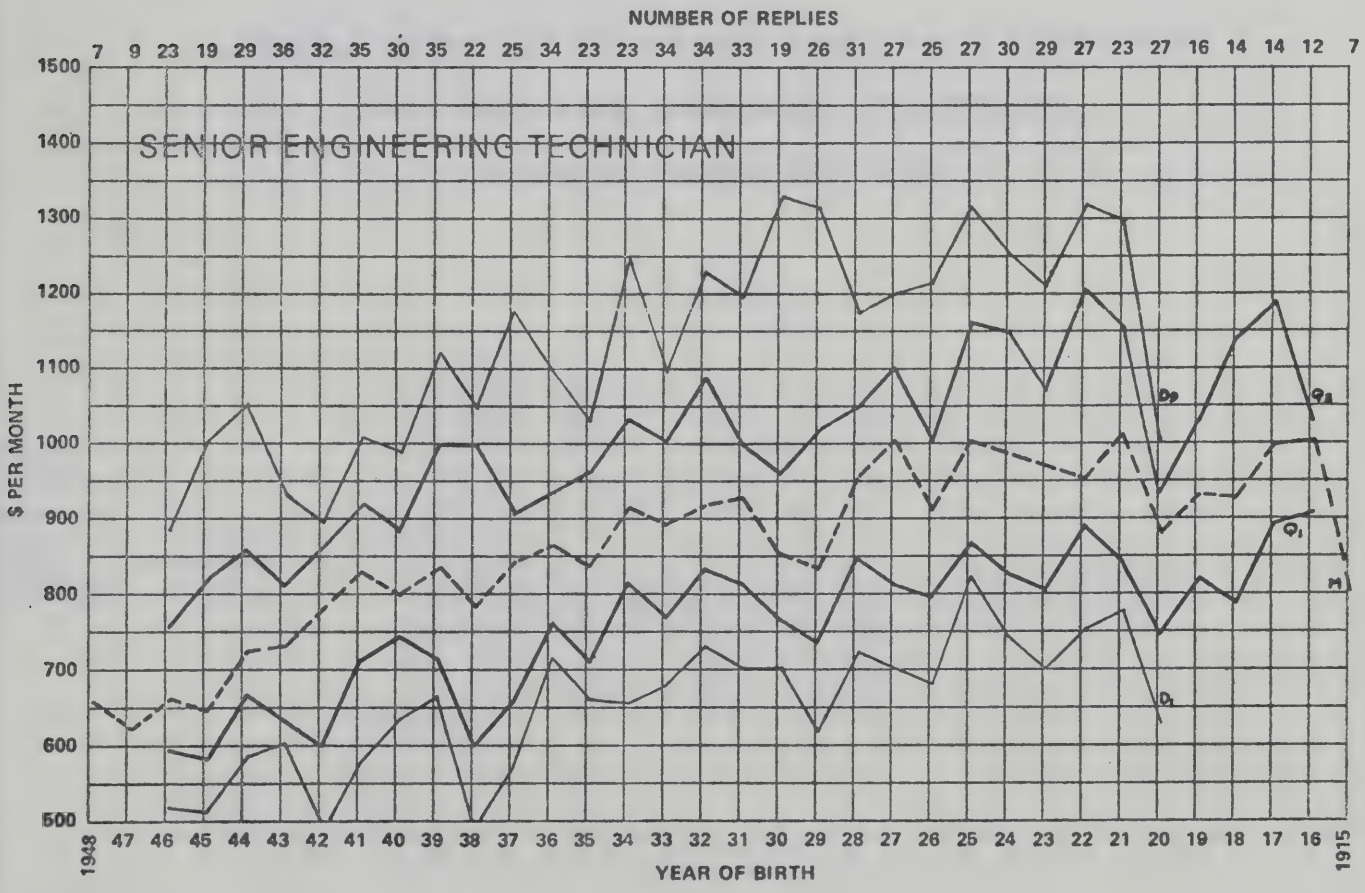
INTERPRETATION

The spread of salaries is illustrated by the use of deciles (D_1, D_9) and quartiles (Q_1, Q_3) on either side of the median. The deciles indicate 10% and 90%. The quartiles indicate 25% and 75%. The median (M) is the middle salary reported i.e. if 51 replies are tabulated for any one year, then the 26th salary in ascending or descending order is the median salary. The median is not an arithmetic average.

The usual warnings apply when using the graphs. The curves show trends and distributions. Comparisons should not be made on an individual basis. The returns have not been reviewed for occupation or geographical location and refer to July 1st, 1971.




NUMBER OF REPLIES
7 15 41 50 83 84 86 78 59 48 52 44 37 30 35 31 30 28 27 16 16 19 20 17 15 16 13 11 11 10 3 4 8 4
ENGINEERING TECHNOLOGIST
$ PER MONTH
1500
1400
1300
1200
1100
1000
900
800
700
600
500
1948
47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16
1915
YEAR OF BIRTH
D3
Q3
M
Q1
D1


NUMBER OF REPLIES
7 9 23 19 29 36 32 35 30 35 22 25 34 23 23 34 34 33 19 26 31 27 25 27 30 29 27 23 27 16 14 14 12 7
SENIOR ENGINEERING TECHNICIAN
$ PER MONTH
1500
1400
1300
1200
1100
1000
900
800
700
600
500
1948
47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16
1915
YEAR OF BIRTH
D3
Q3
Q1
M
D1

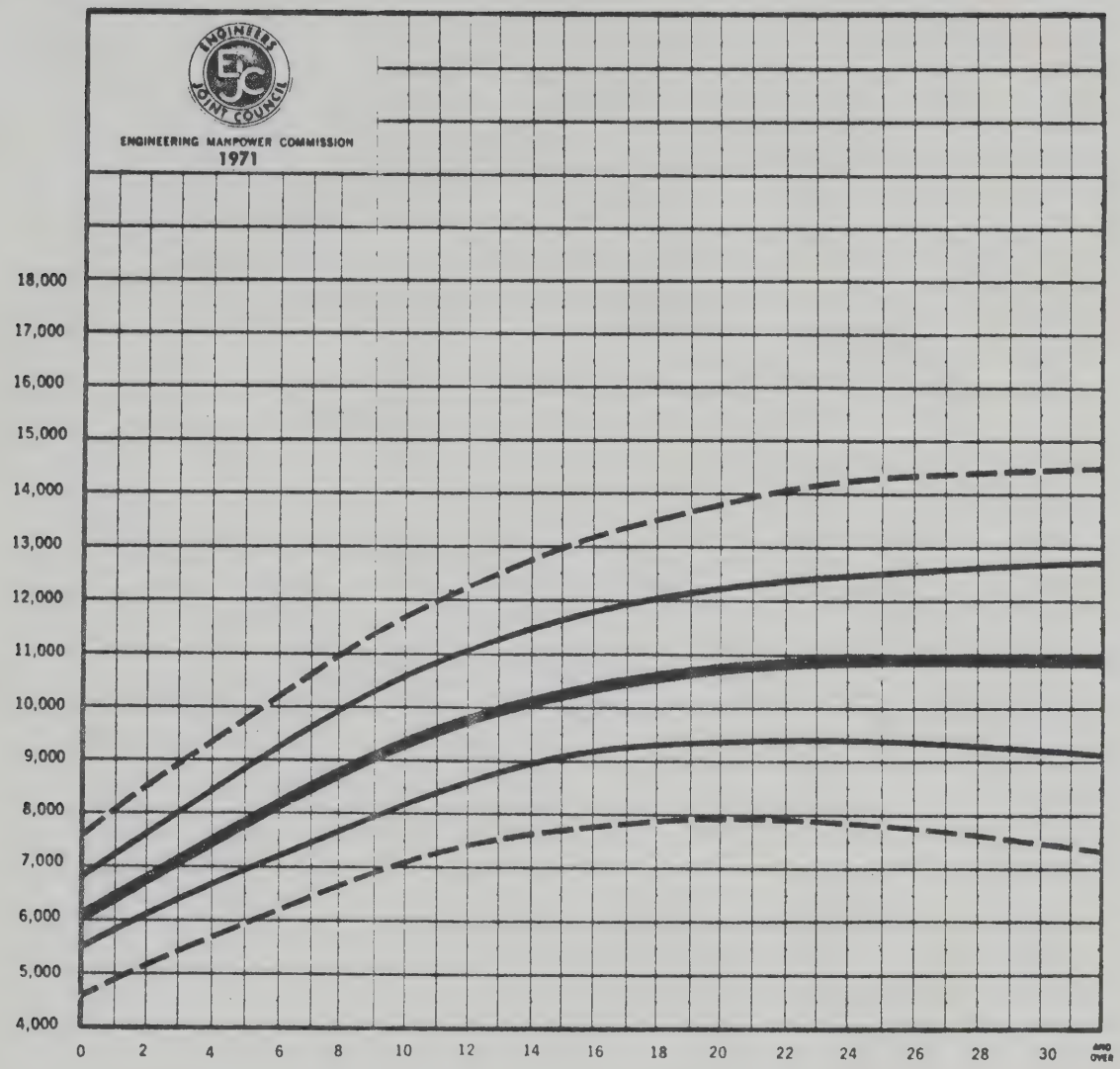
APPENDIX C

Annual Salary by Equivalent Years Since Graduation from Technical Institute, Engineering

Manpower Commission, U.S.

Annual Salary by Equivalent Years Since Graduation from Technical Institute*

NONGRADUATE TECHNICIANS
ENTIRE U.S.



LEGEND

- Upper Decile
- Upper Quartile
- Median
- Lower Quartile
- Lower Decile

ALL TECHNICIANS

YEARS	0	1	2	3	4	5	6	7	8
UPPER DECILE	7600	8050	8500	8950	9400	9800	10240	10600	11000
UPPER QUARTILE	6800	7250	7650	8100	8500	8900	9250	9600	9950
MEDIAN	6150	6500	6850	7200	7500	7850	8150	8500	8800
LOWER QUARTILE	5500	5750	6050	6300	6600	6850	7100	7400	7650
LOWER DECILE	4650	4900	5150	5400	5700	5950	6150	6400	6650
MEAN	6150	6500	6850	7200	7550	7900	8250	8550	8850
TOTAL NUMBER	556	651	1497	1360	1836	1761	1794	2090	2346
NUMBERS OVER $16000	0	0	0	0	0	0	1	3	4
NUMBERS UNDER $4000	0	0	0	0	0	0	0	0	0

YEARS	9-11	12-14	15-17	18-20	21-23	24-26	27-29	30-34	35+
UPPER DECILE	11700	12550	13200	13700	14050	14250	14400	14500	14550
UPPER QUARTILE	10550	11250	11800	12150	12400	12600	12650	12750	12750
MEDIAN	9350	10000	10450	10750	10850	10900	10850	10800	10700
LOWER QUARTILE	8100	8700	9150	9400	9450	9400	9250	9050	8650
LOWER DECILE	7050	7500	7750	7850	7850	7700	7550	7350	7050
MEAN	9400	10000	10450	10700	10850	10900	10900	10900	10900
TOTAL NUMBER	5571	5296	4935	4403	3898	3721	3394	4576	5035
NUMBERS OVER $16000	11	30	30	59	62	96	103	176	174
NUMBERS UNDER $4000	0	0	0	0	0	0	0	0	0

NUMBER OF TECHNICIANS COVERED - 54720

*Base year (0 years since graduation) is 1971. For Associate degrees and non-graduates this is considered equivalent to age 20. For Bachelor's degree the equivalent age is 22.